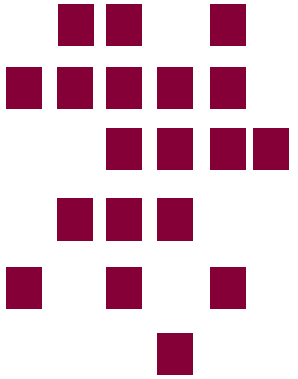
GGS-INTERICA

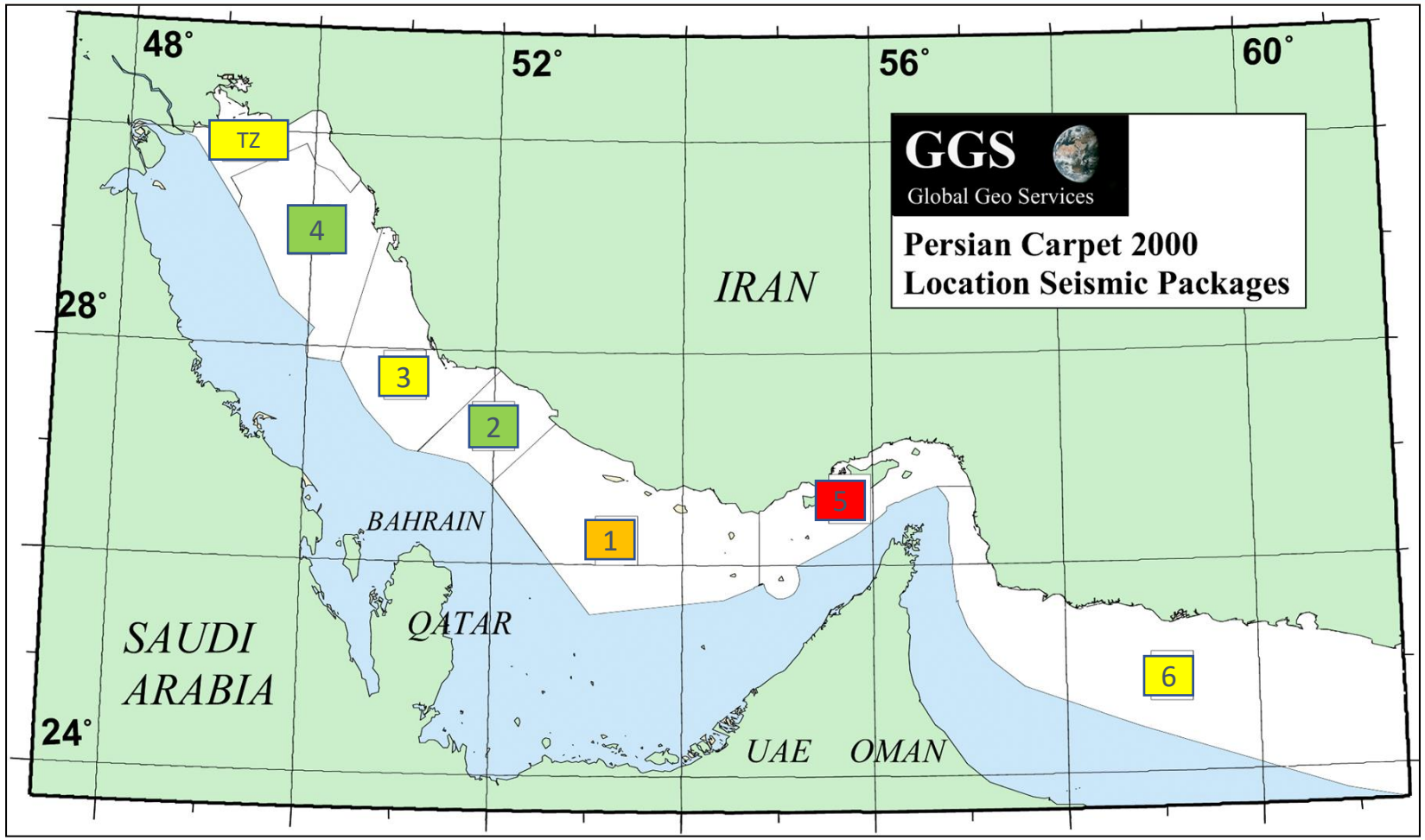
PC 2000

Data Reprocessing



London, 22nd of May 2018

Reprocessing Status



- Reprocessed areas
- Reprocessing to be completed in Q2 2018
- Reprocessing to be completed in Q3 2018
- Reprocessing to be completed soon

Current Progress

	Area 4 16,755 km	Area 2 7,151 km	TZ marine 3,771 km	TZ mixed source 2,741 km	Oman Sea 15,283 km	Area 3 13,954 km	Area 1 27,073 km	Area 5 3,580 km	Pseudo 3Ds 11,493 km
Data load	√	√	√	√	√	√	√	√	√
Navigation	√	√	√	√	√	√	√	√	√
Noise attenuation / SI	√	√	√	√	√	√	√	Confirmation tests	Confirmation tests
Deghosting	√	√	√	√	√	√	→		
Debubble	√	√	√	√	√	√	→		
Zero phasing	√	√	√	√	√	√	→		
Demultiple	√	√	√	√	√	√	Confirmation testing		
Fast-track	√	N/A	N/A	N/A	N/A	N/A	N/A		
Linear/Parabolic Radon	√	√	√	√	√	√			
Q / amplitude balancing	√	√	√	√	√	√			

Key
√ = Step completed
→ = Production running

Current Progress

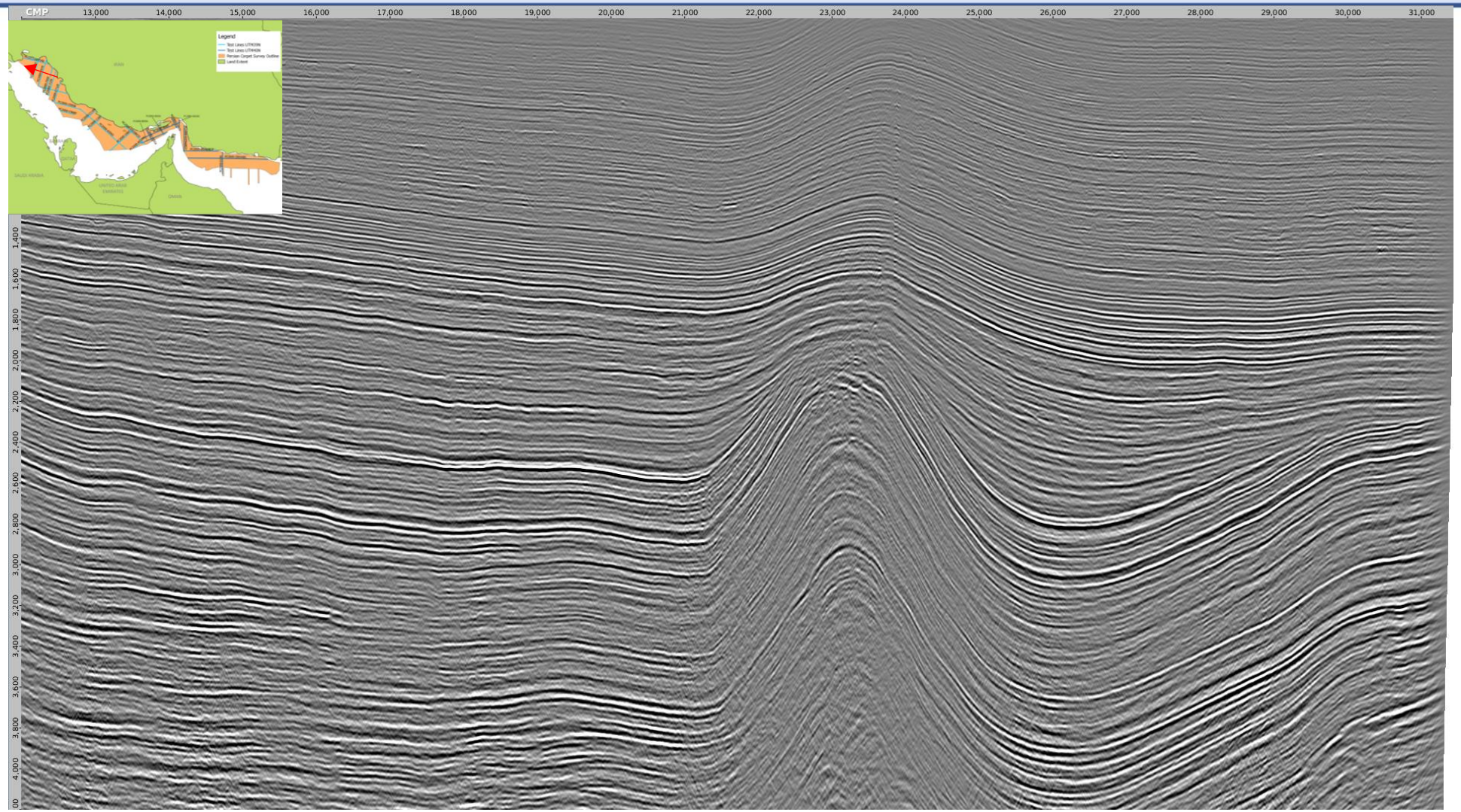
	Area 4	Area 2	Merged Areas TZ, 4 and 3	Oman Sea	Merged Areas 1 and 2	Area 5	Pseudo 3Ds
Survey matching	-	-	√	√			
Migration velocities	√	√	√	√			
Production migration	√	√	→	→			
Post migration RMO	√	√	→	→			
Post migration Radon	√	√	→	→			
Stacking	√	√	→	Confirmation testing			
Post-stack	√	√	Confirmation testing				
Convert to SEGY	√	√					
Deliver stacks	√	√					
Deliver velocities	√	√					

Key
√ = Step completed
→ = Production running

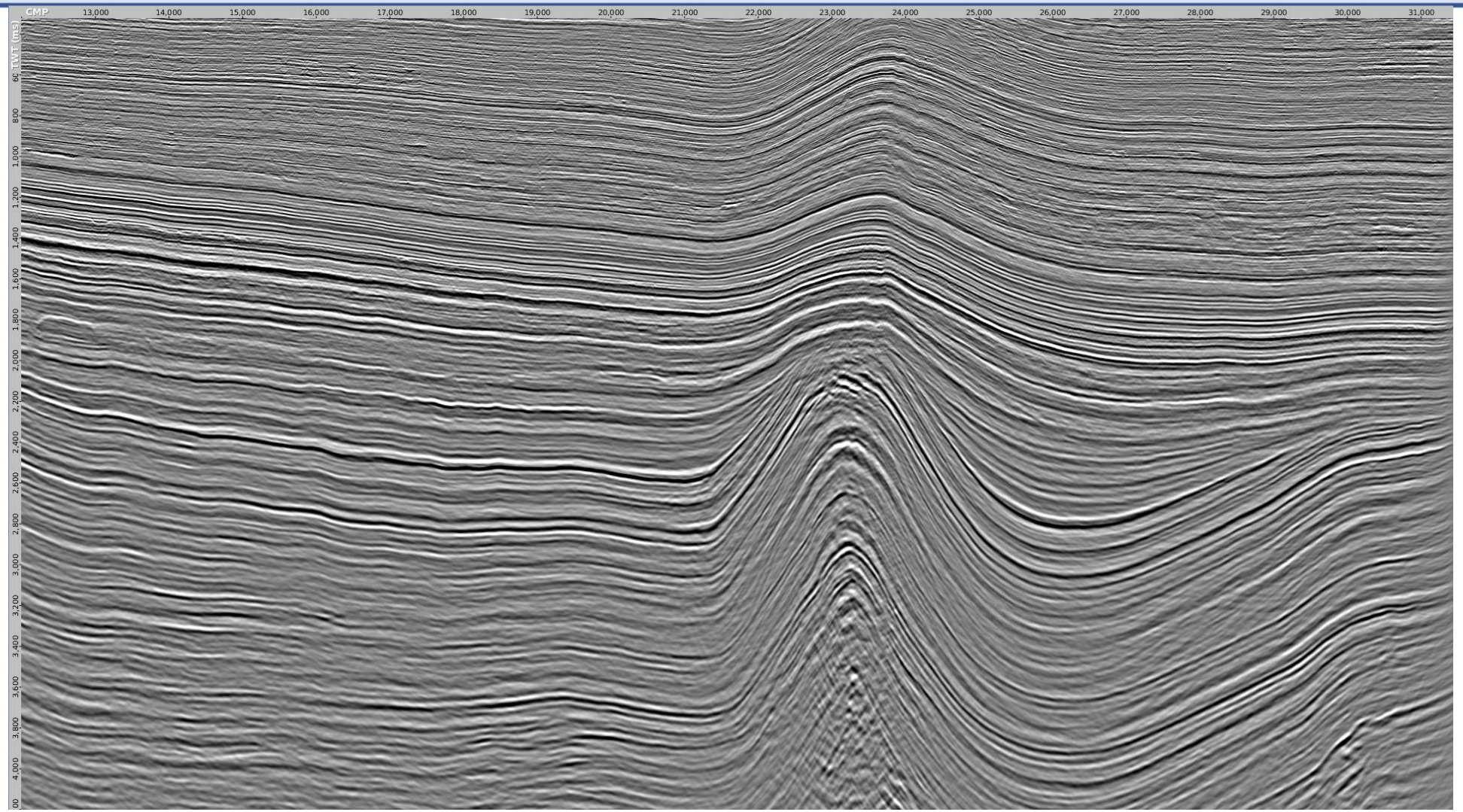
Reprocessing Sequence
Area 4, 2

- Navigation merge
- Low cut filter (2-3Hz)
- Mud roll attenuation
- Swell noise attenuation
- Direct arrival attenuation
- Linear noise attenuation
- Seismic interference attenuation
- Receiver motion correction
- Deghosting
- Designature
- DUG SWaMP
- Water bottom muted SRME
- Long period SRME
- Tau-P deconvolution
- Linear Radon and CMP noise attenuation
- Inverse phase only Q correction
- Surface consistent amplitude balancing
- Migration velocity analysis
- 2D Kirchhoff time migration
- Post migration RMO correction
- Post migration Radon demultiple
- Post migration noise attenuation
- 2 - 32 degree full stack
- T-X deconvolution
- Amplitude only Q correction
- Residual spectral shaping
- Residual noise attenuation

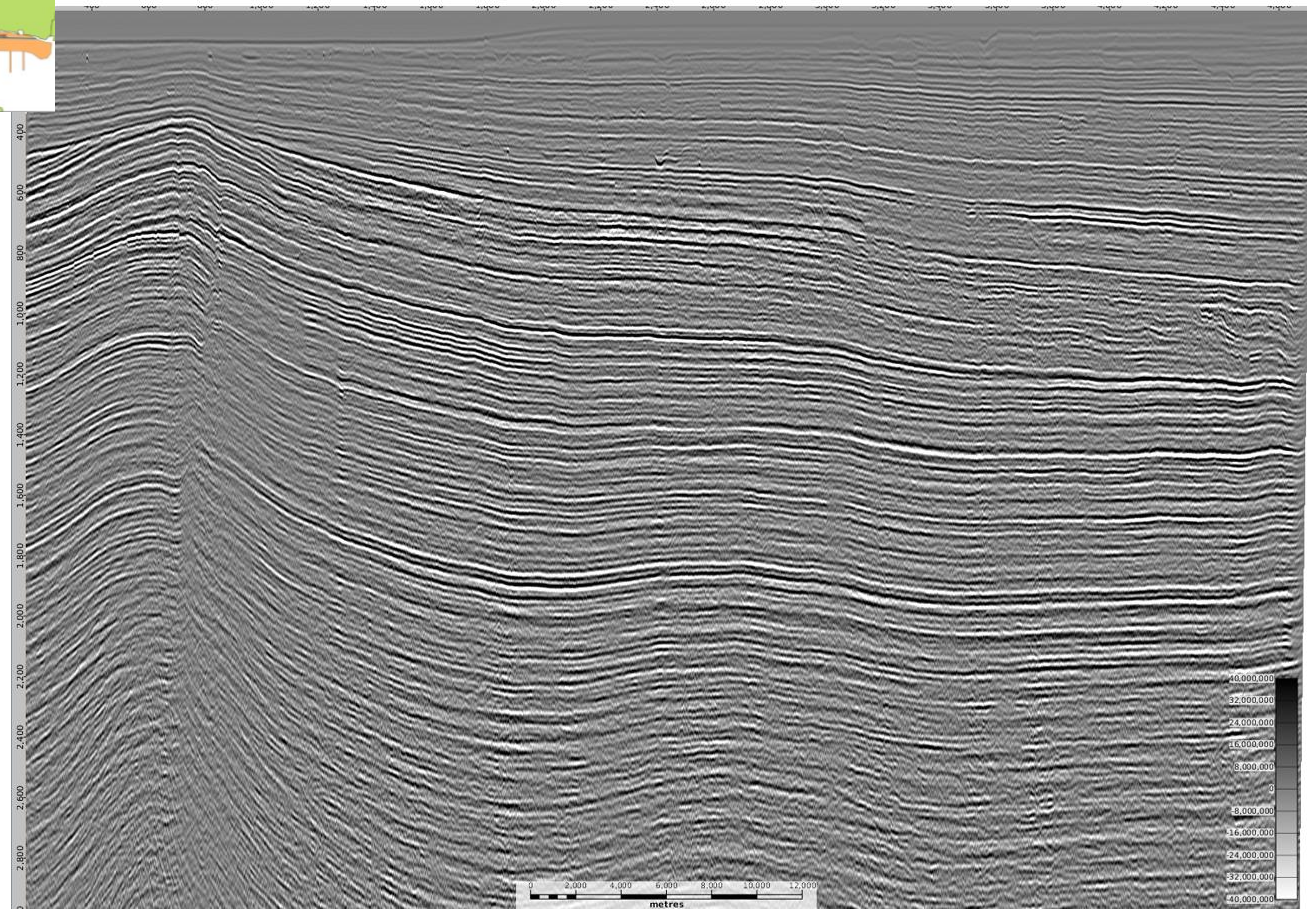
Line 9172bc: Legacy Stack



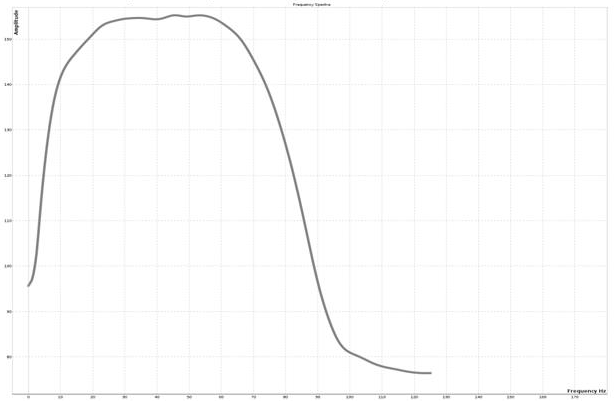
Line 9172bc: Reprocessed



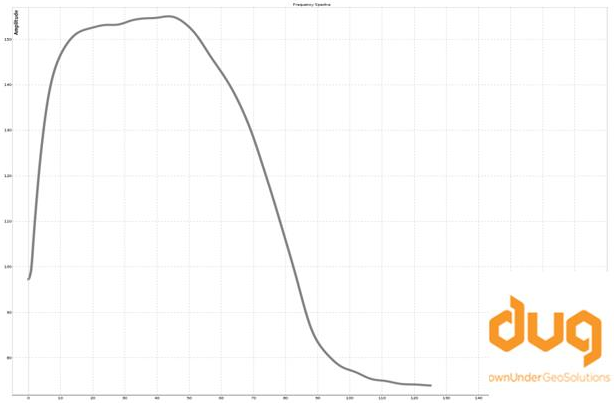
Line C1213: Legacy Stack



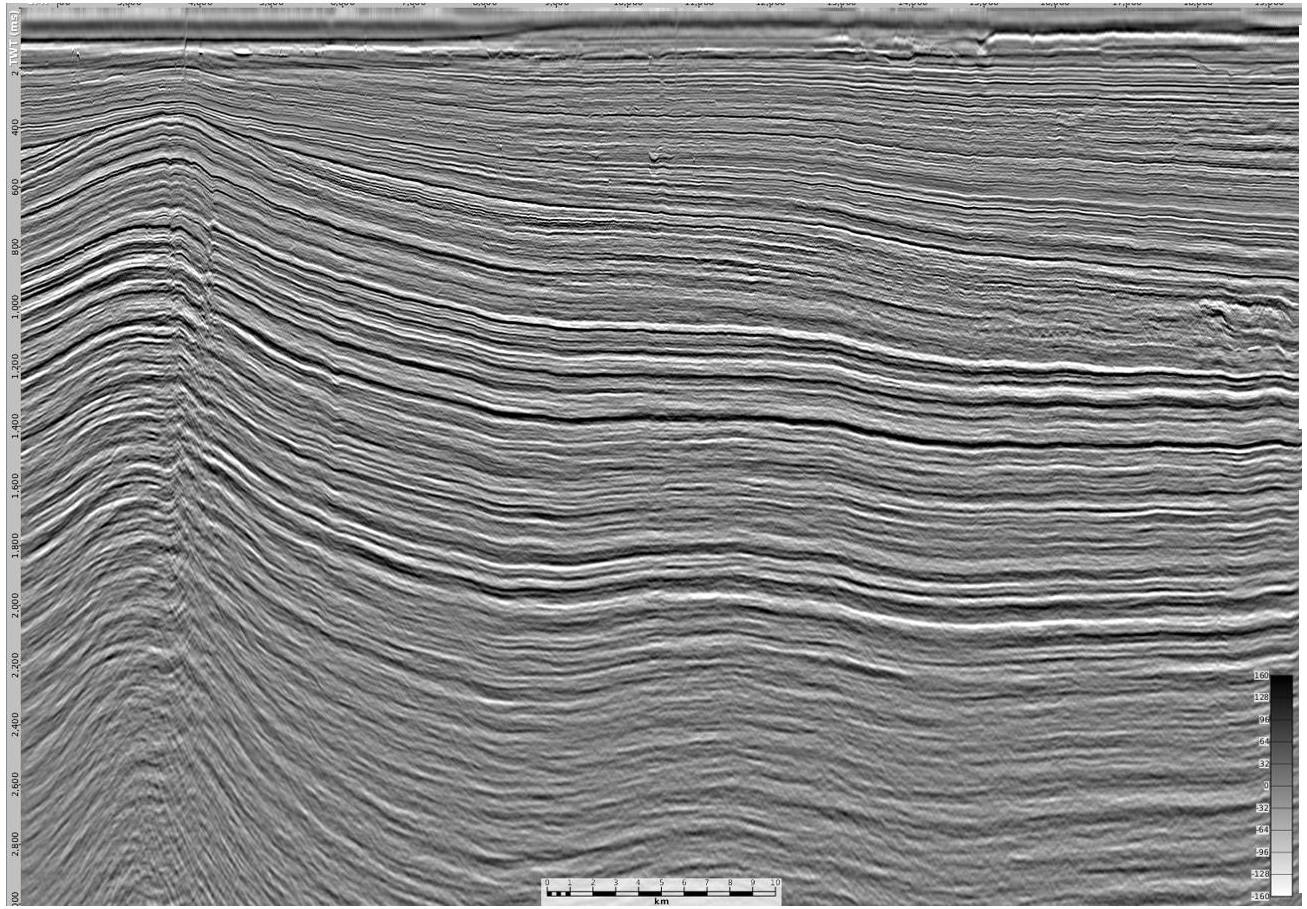
Shallow spectra (200 – 1200 ms)



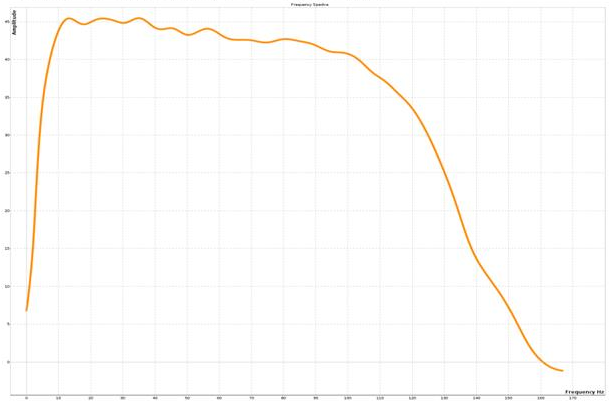
Deep spectra (1300 – 2900 ms)



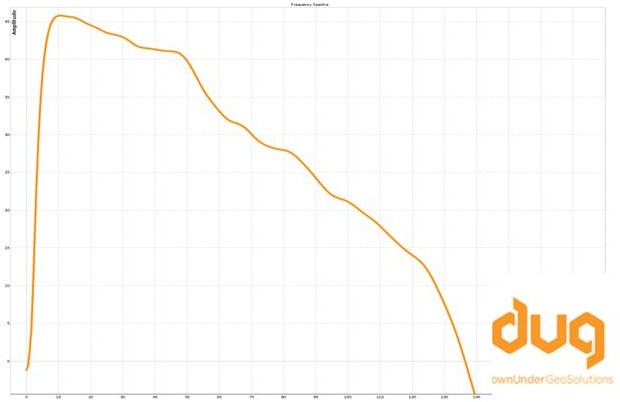
Line C1213: Reprocessed



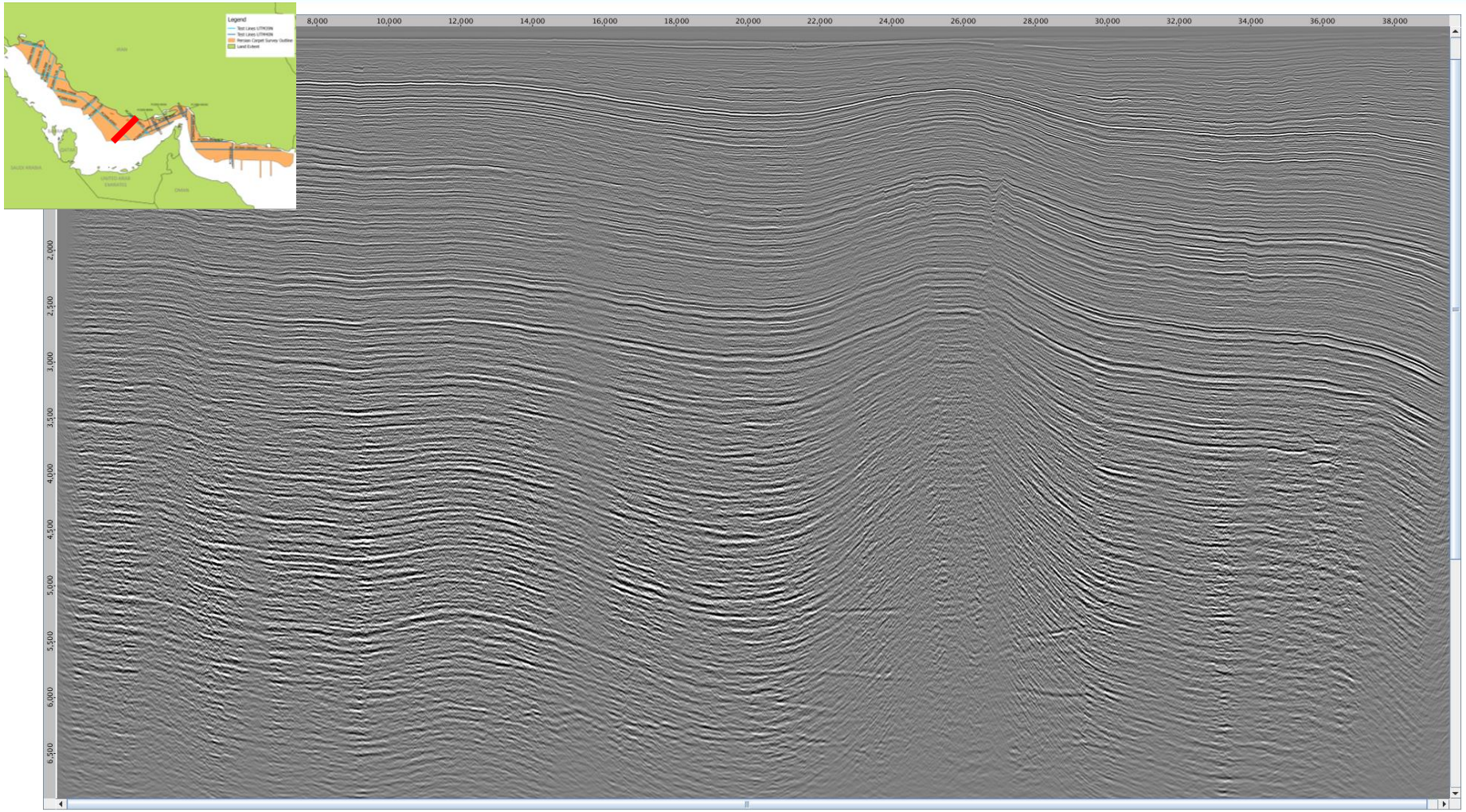
Shallow spectra (200 – 1200 ms)



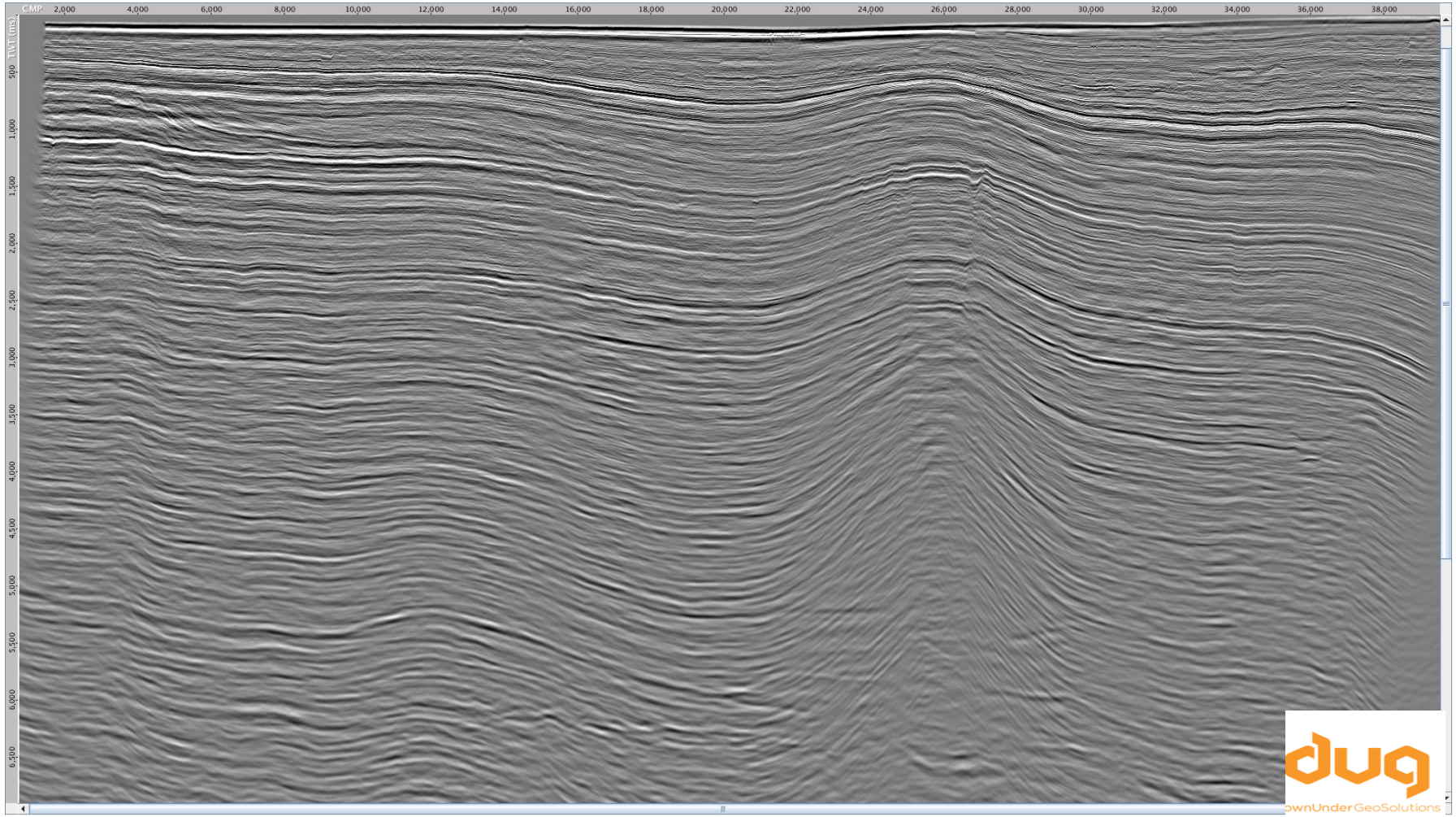
Deep spectra (1300 – 2900 ms)



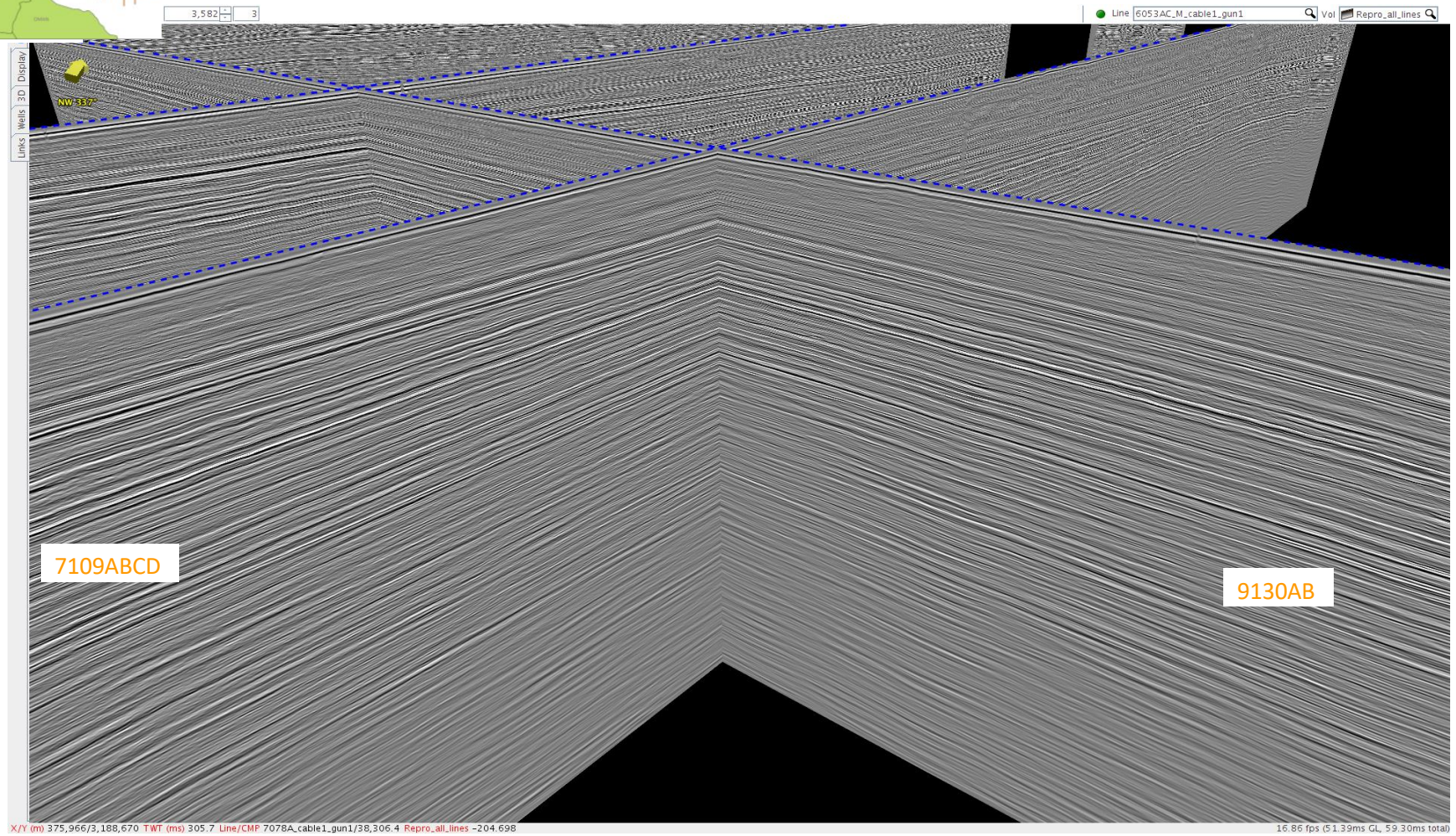
Line 1080 - Legacy



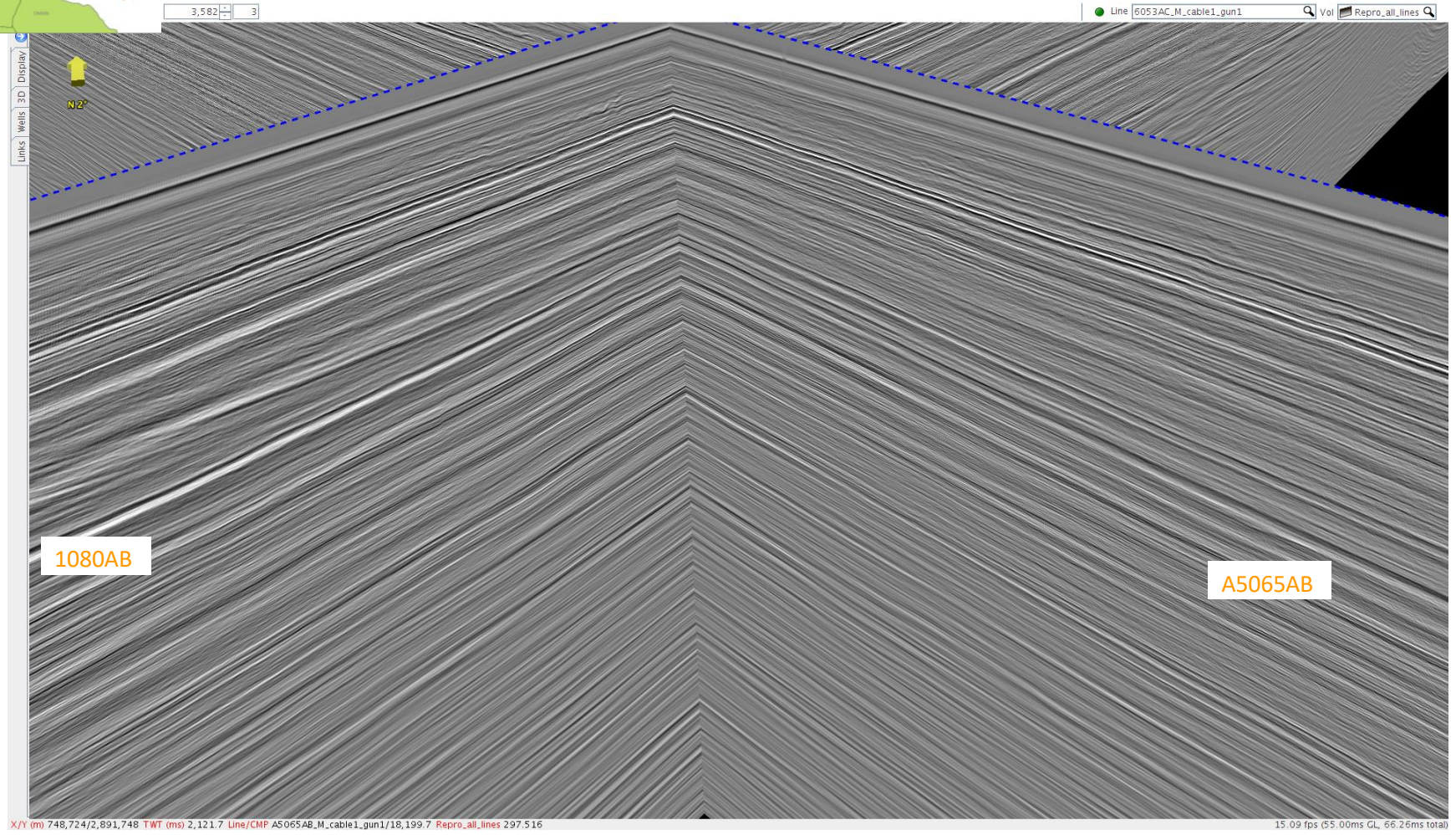
Line 1080 - Reprocessed



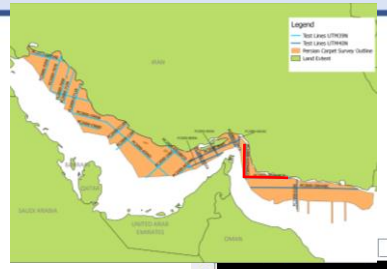
Intersects with 9130AB

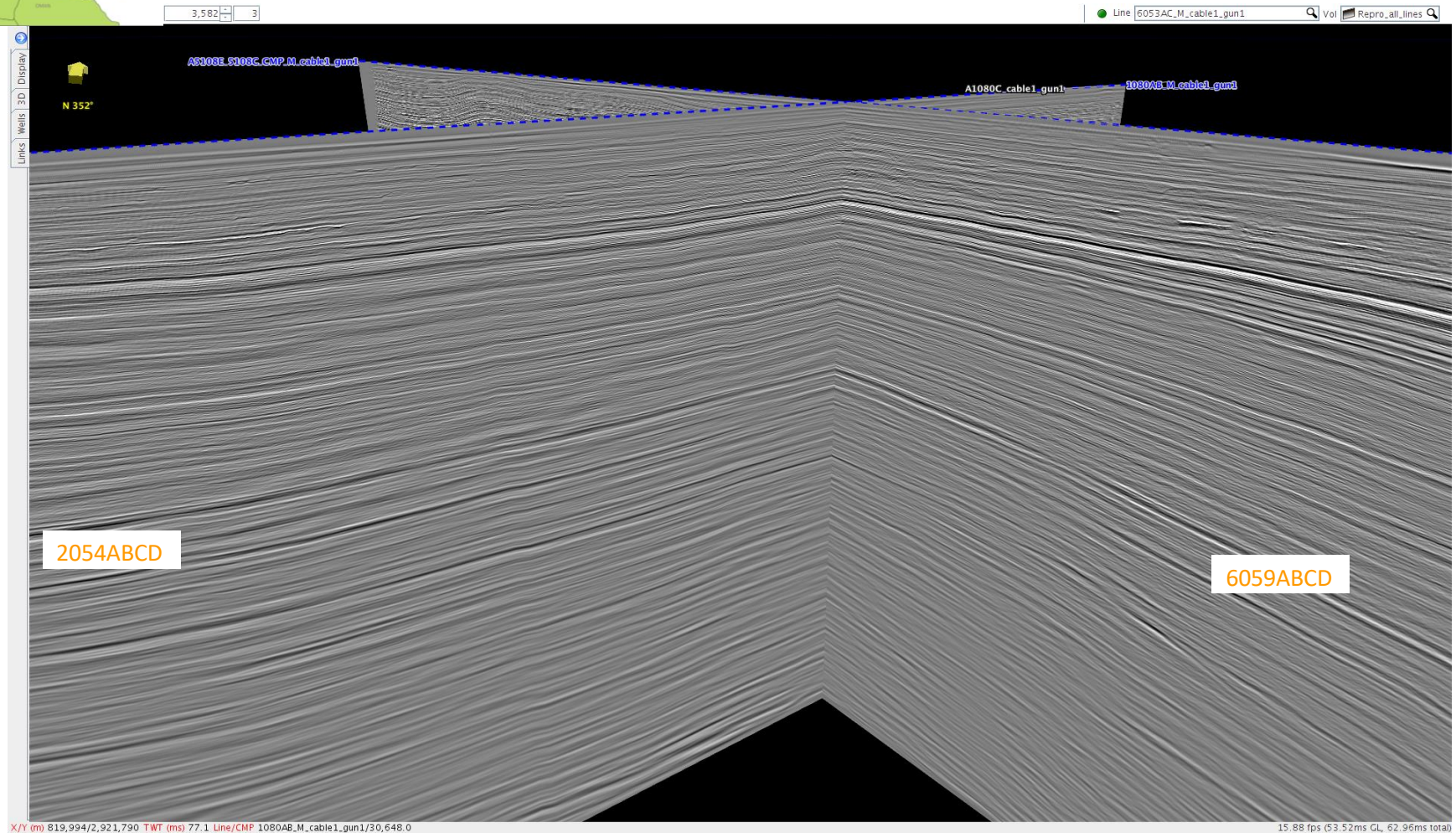


Intersects 1080AB with A5065AB



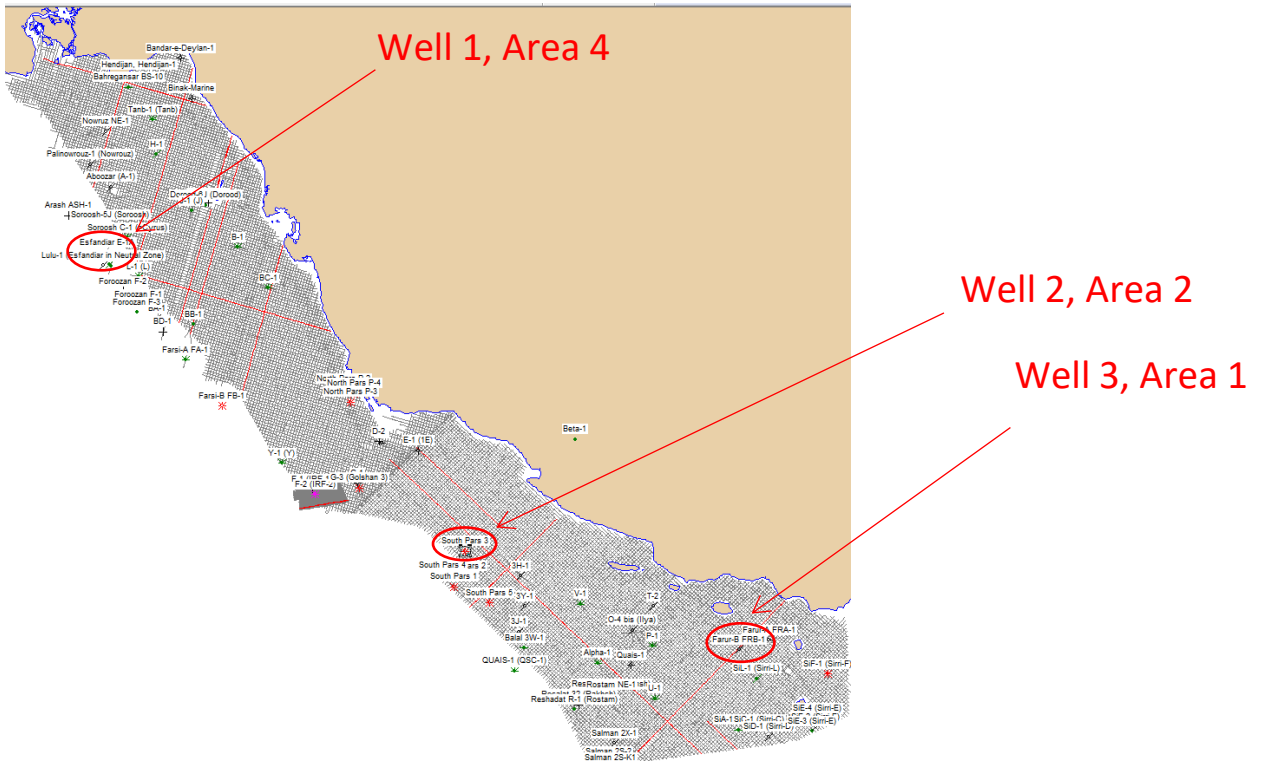
Intersects 2054ABCD with 6059ABCD



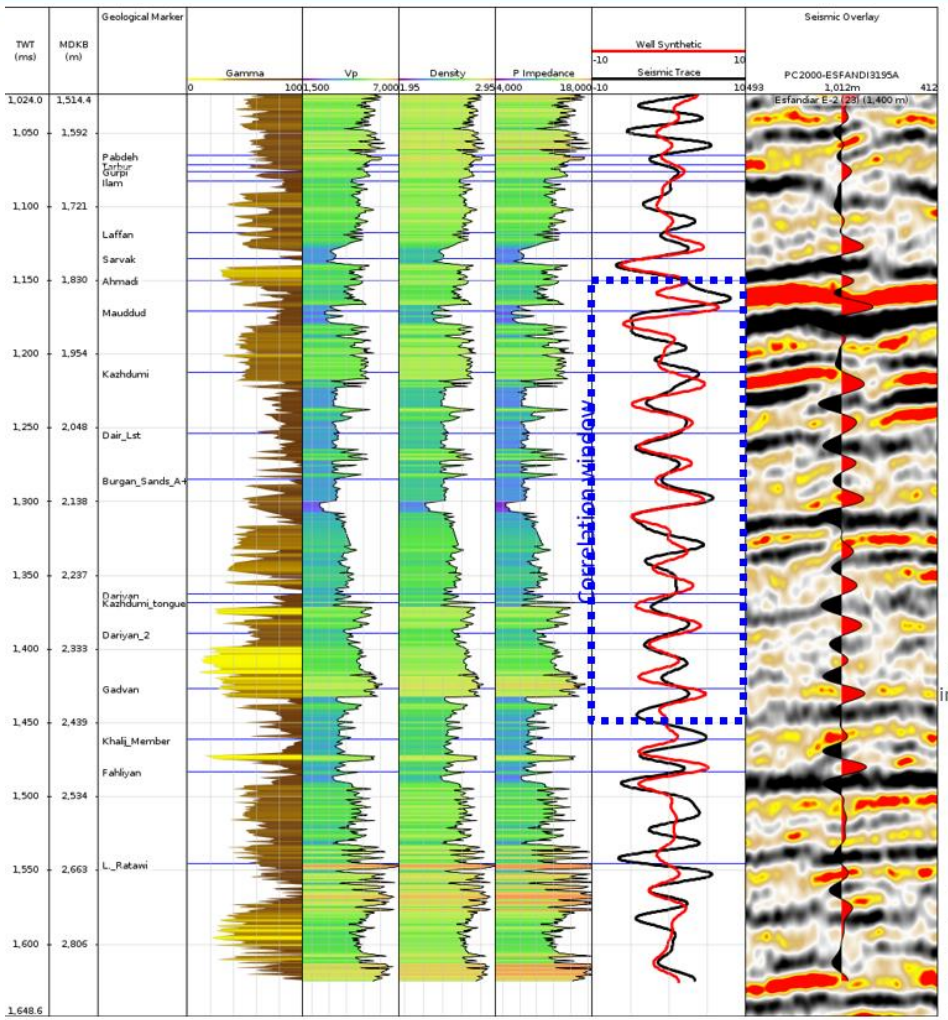


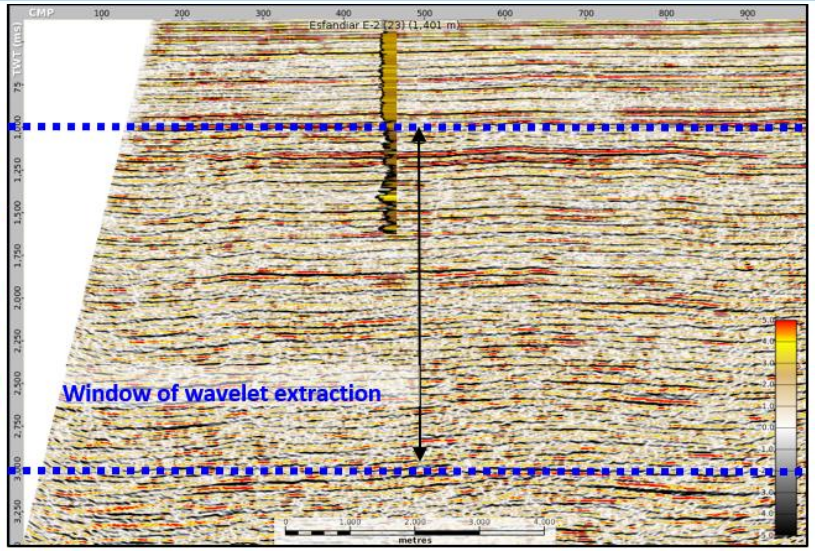
Well ties

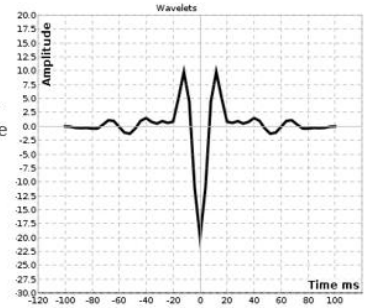
- Well ties were created for 3 wells using the DUG reprocessed volumes.
- We see an increase in cross correlation in the reprocessed volumes indicating that the processing is boosting higher frequencies enabling better imaging of geology.

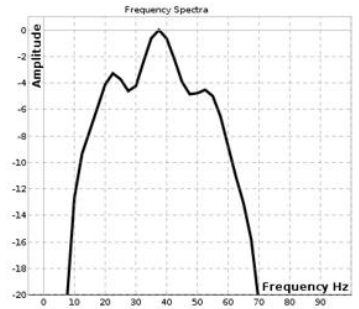


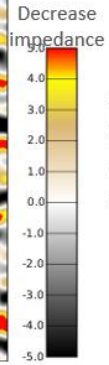
Well tie: Legacy well tie





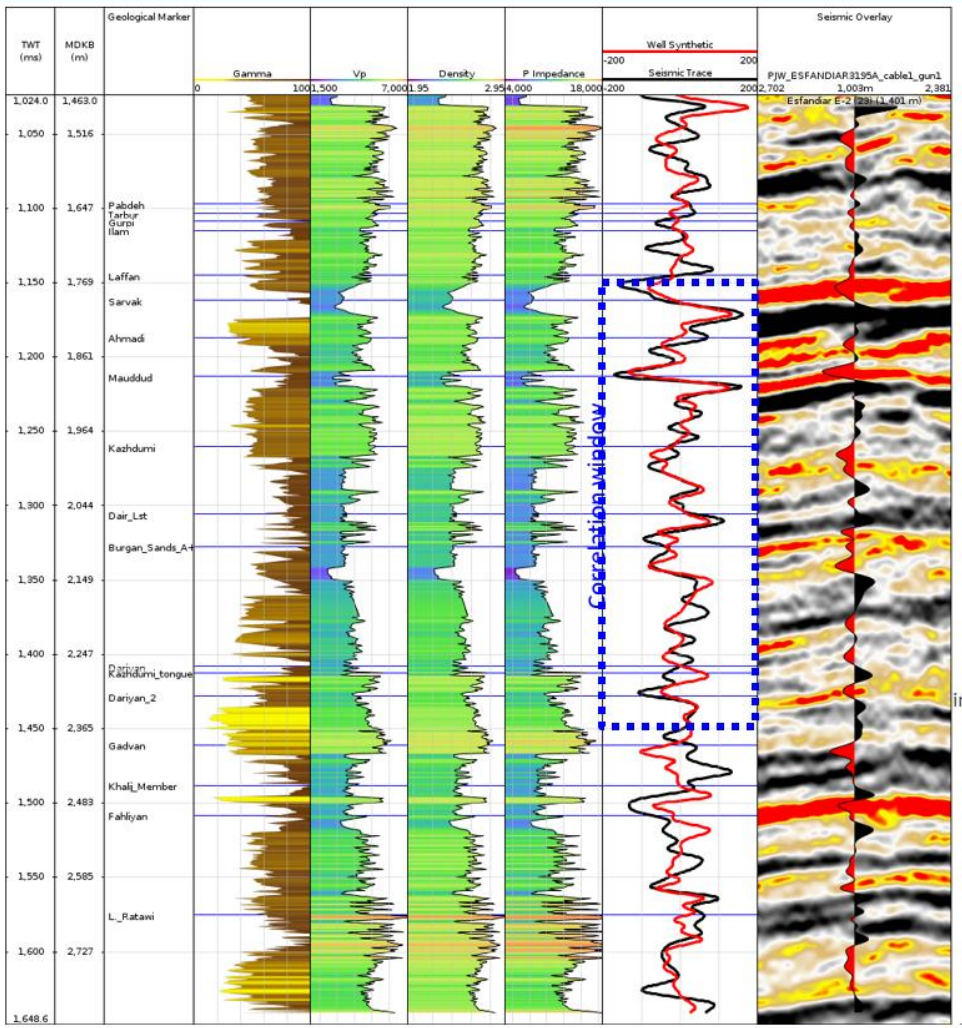


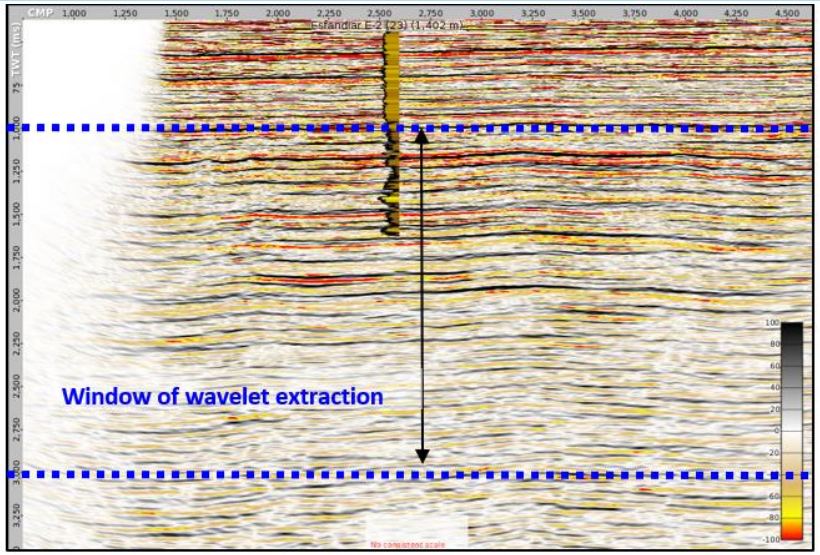




Cross Correlation = 0.65

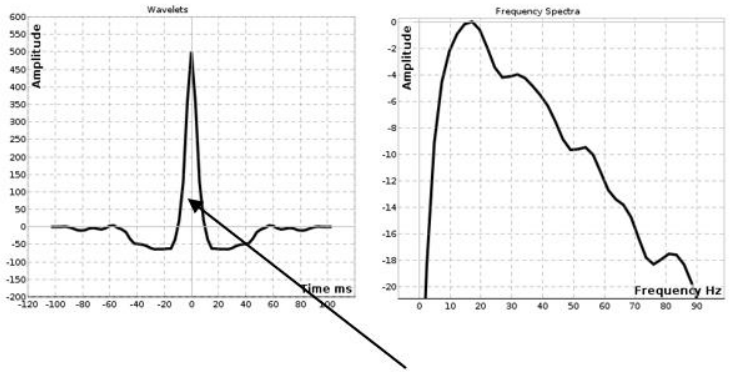
Well tie: Reprocessed well tie





Increase impedance

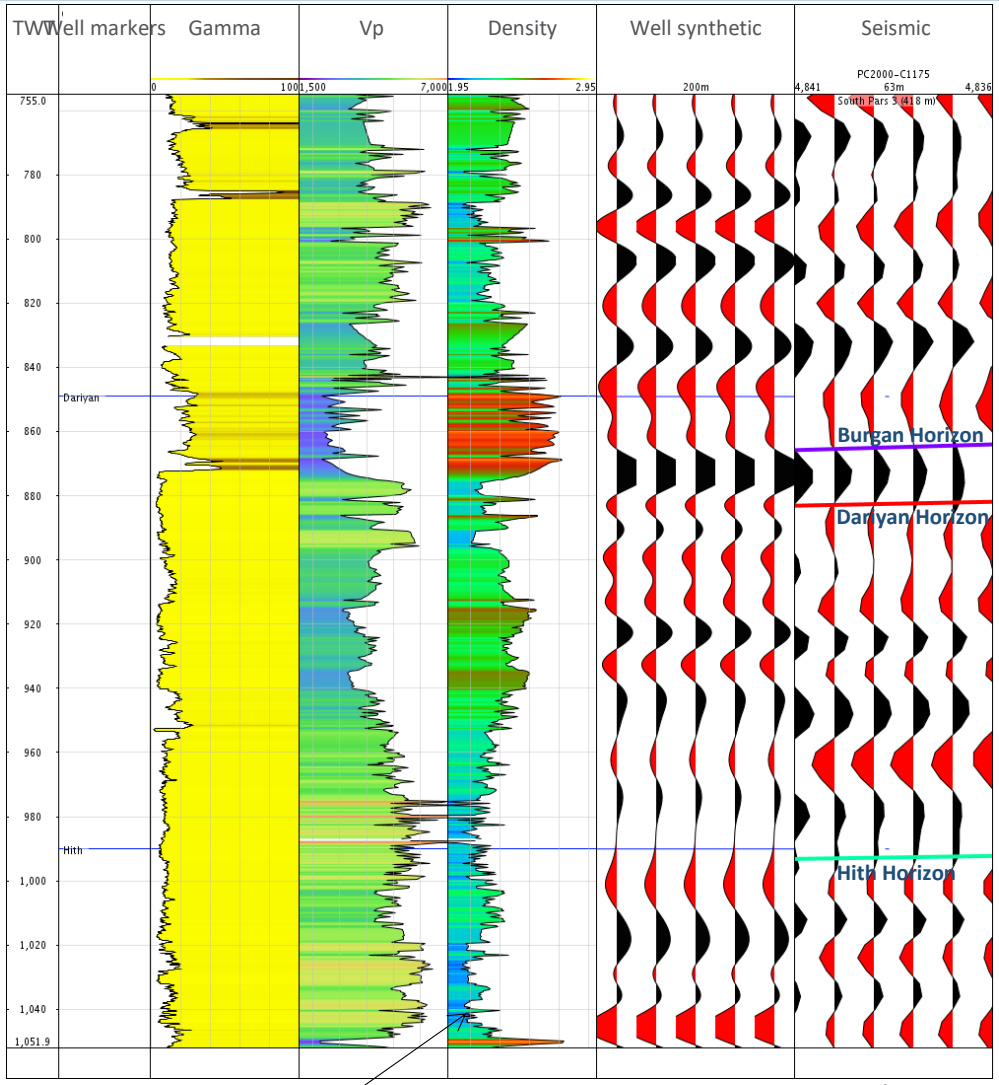
Decrease impedance

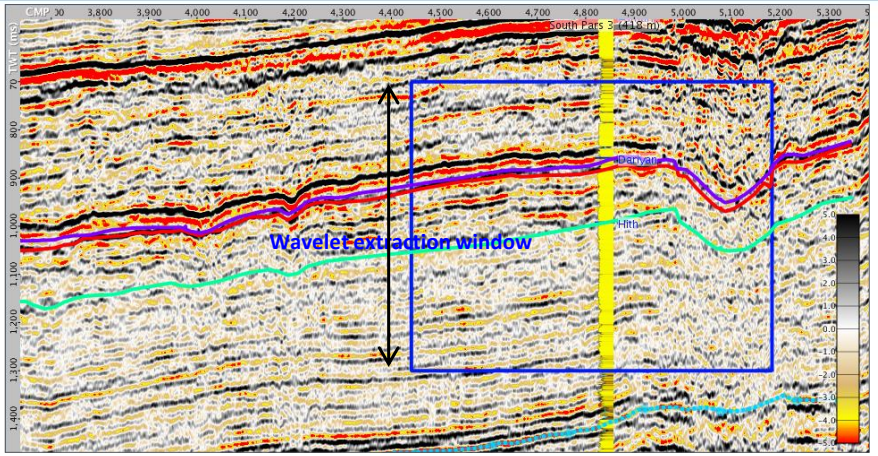


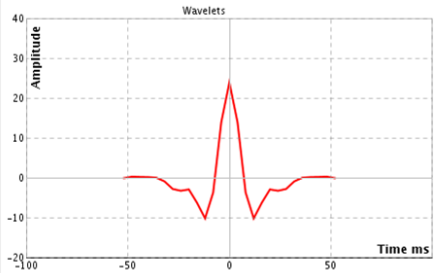
Data is reverse polarity to the legacy data.

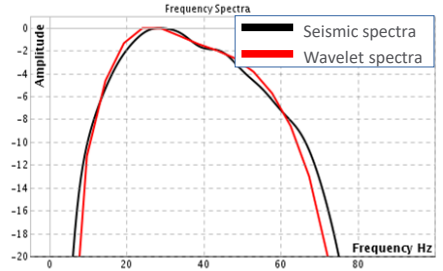
Cross Correlation = 0.77

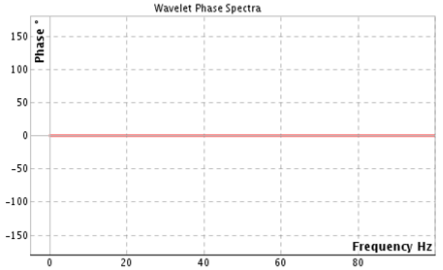
Well tie – Well 2: Original volume









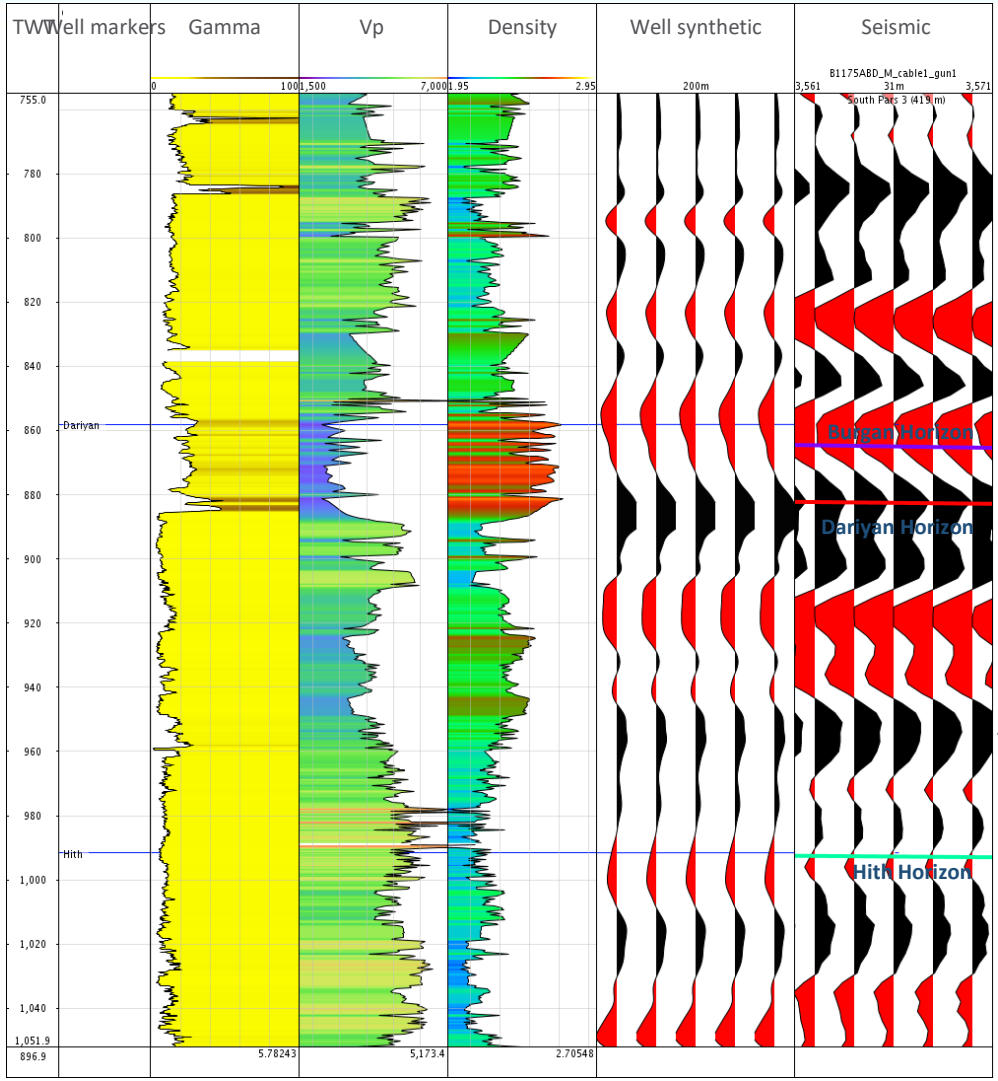


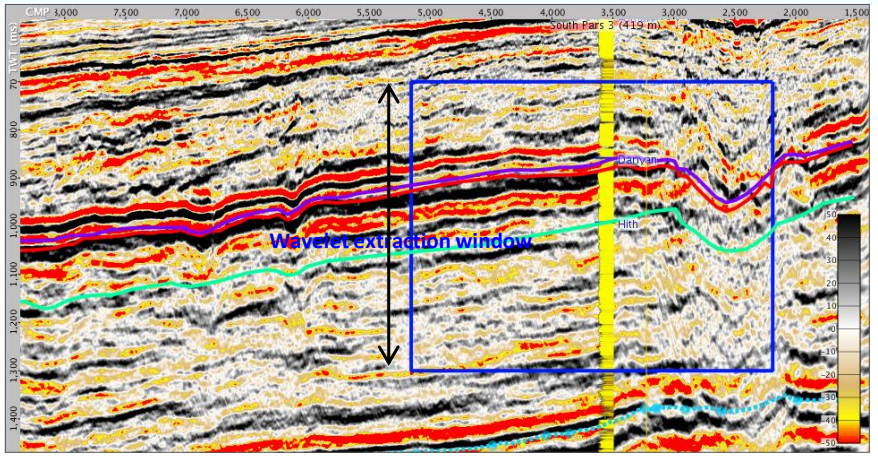
Horizons
Burgan
Hith
Dariyan

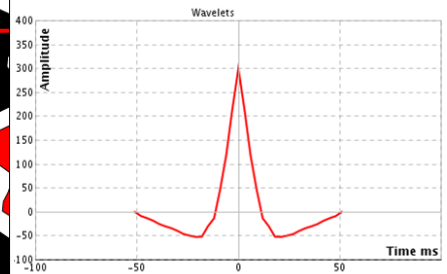
Cross Correlation = 0.61

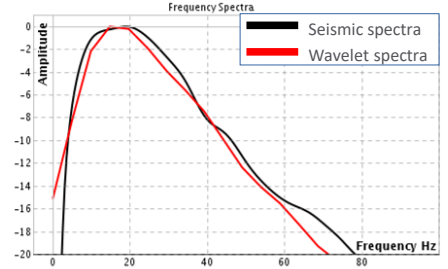
Density has been derived using Gardner's equation.

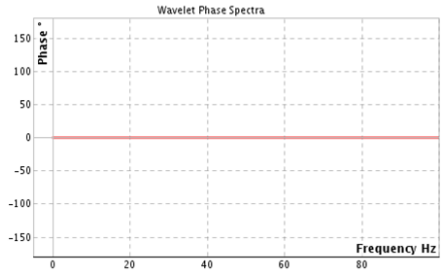
Well tie – Well 2: DUG reprocessed volume







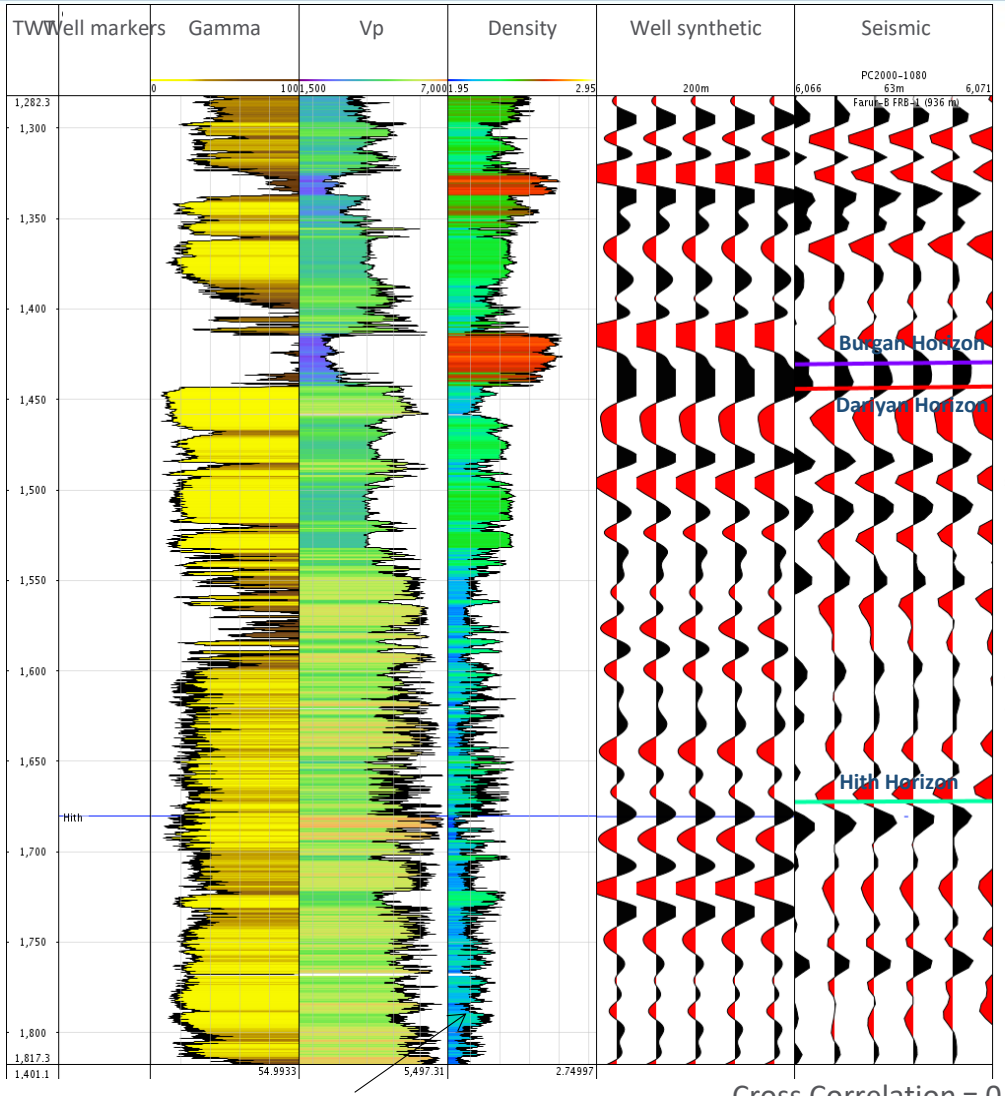


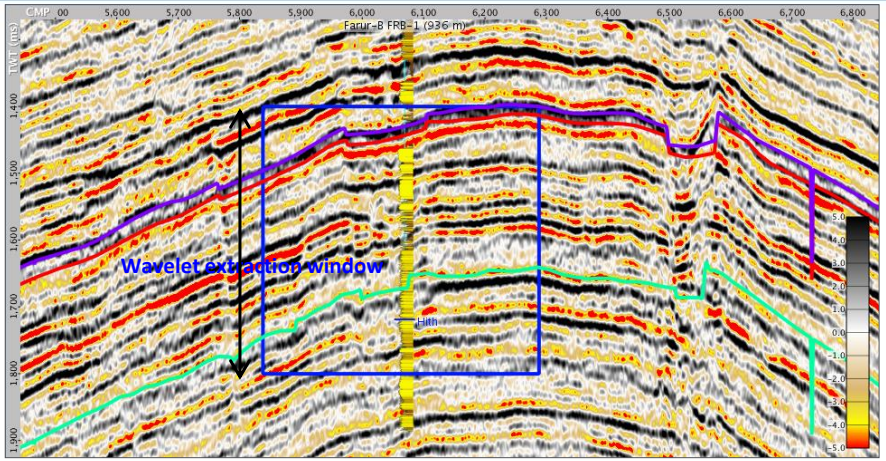


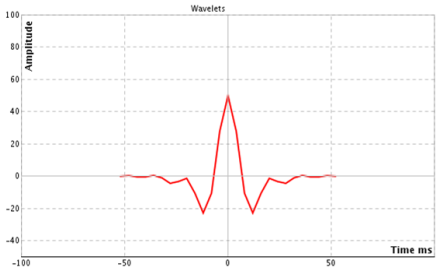
Horizons
Burgan
Dariyan
Hith

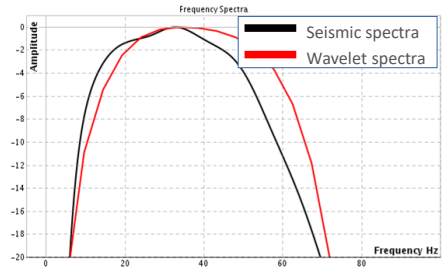
Cross Correlation = 0.64

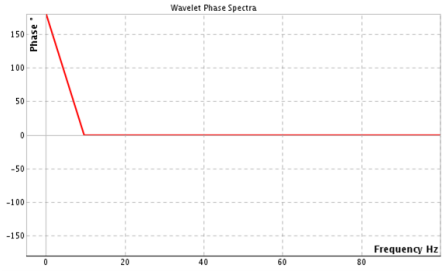
Well tie – Well 3: Original volume









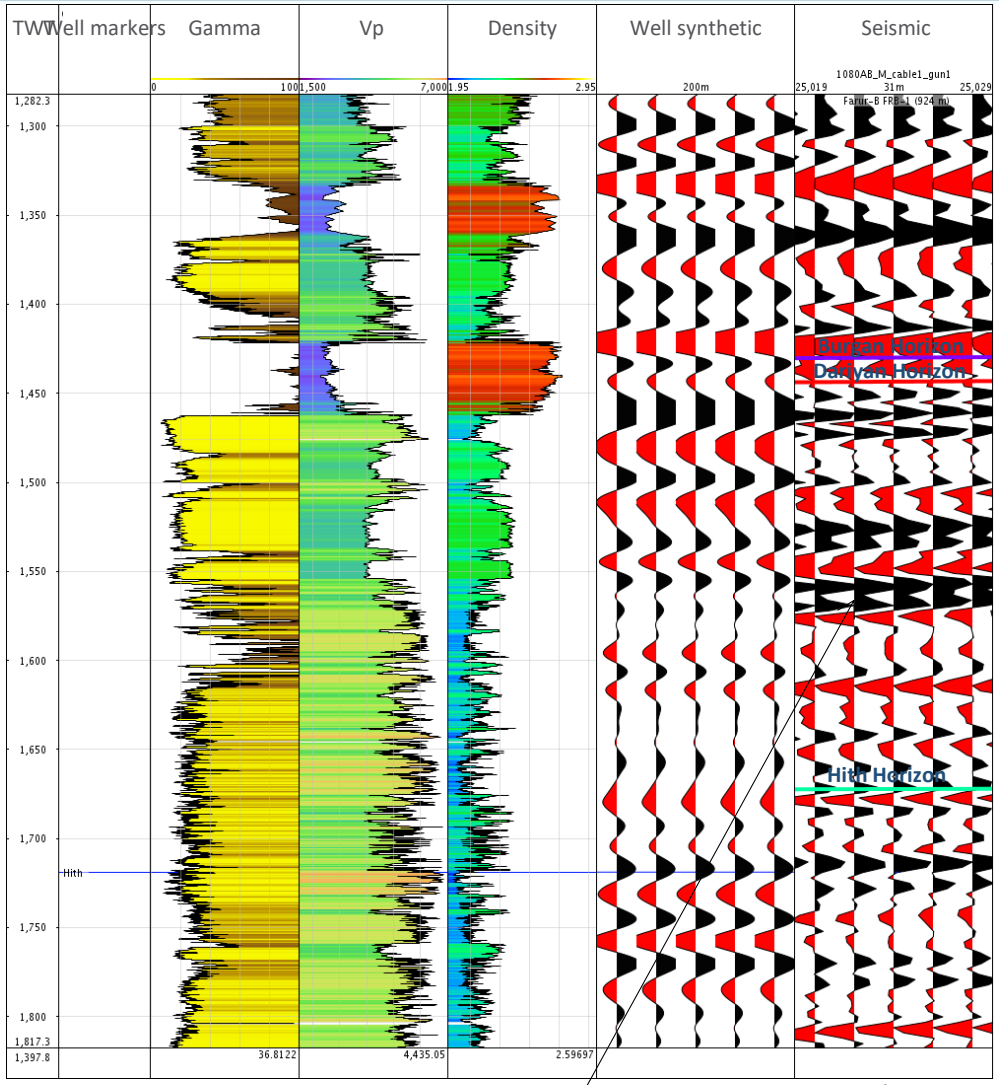


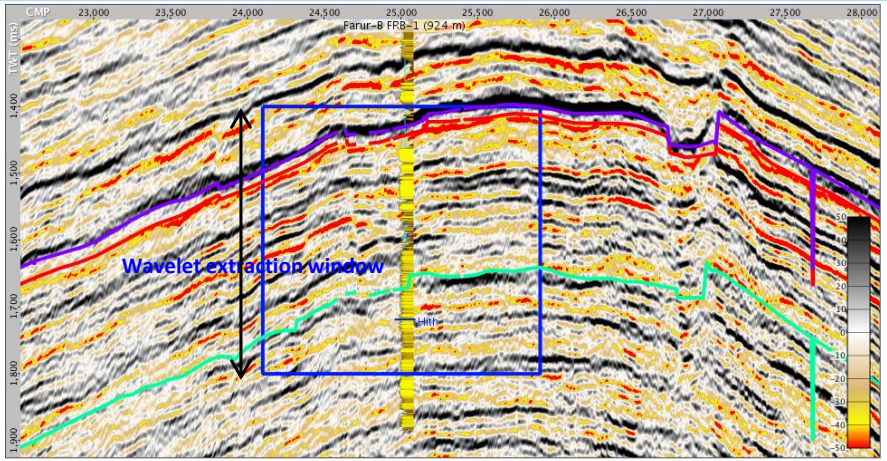
Horizons
Burgan
Hith
Dariyan

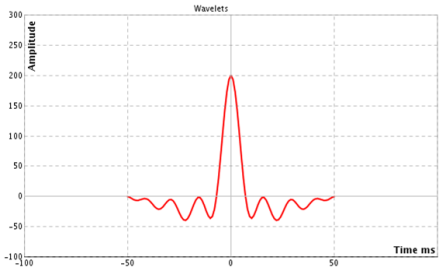
Cross Correlation = 0.68

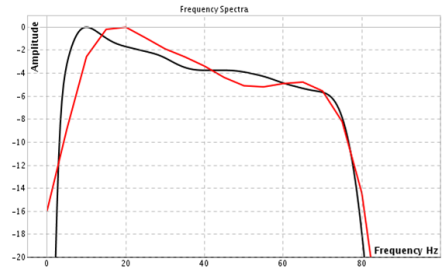
Density has been derived using Gardner's equation.

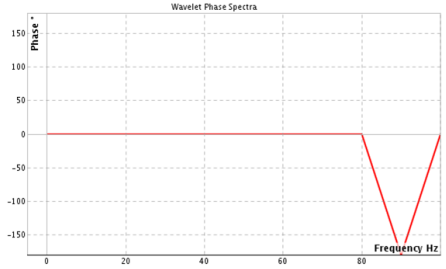
Well tie – Well 3: DUG reprocessed volume











Horizons
Burgan
Dariyan
Hith

Cross Correlation = 0.71

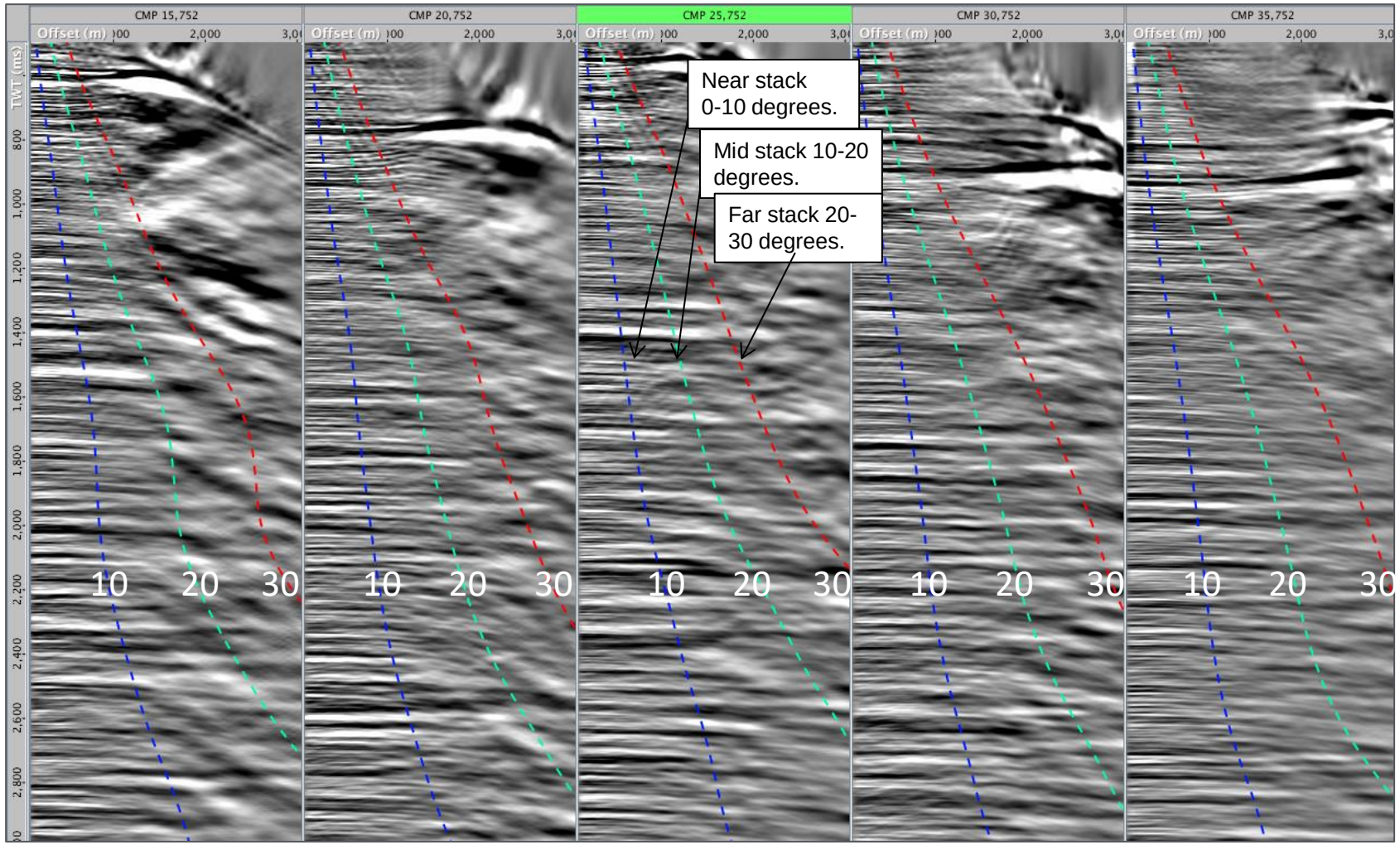
More events are imaged with the reprocessed data.

Relative Inversion: Summary

- A relative inversion was undertaken on the processed gathers along line 1080AB.
- Well 3 was used along the 2D line for wavelet scaling and to QC analyze the inversion results.
- Angle stacks were created from the processed gathers to be used as the input to the inversion.
- These stacks were frequency balanced and aligned to each other prior to inversion.
- Wavelets were extracted from the 3 stacks and scaled to match the stacks.
- The P-impedance volume show a good match to the well.

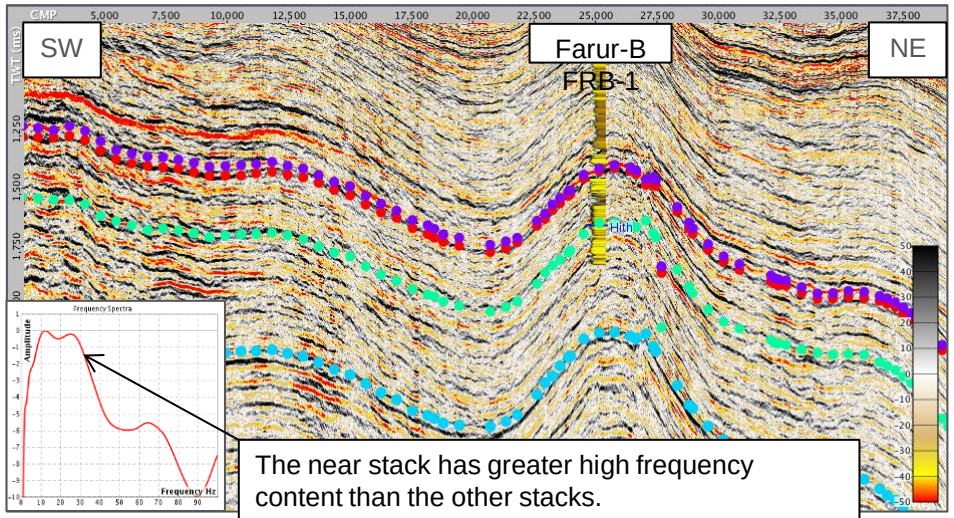
Angle stack creation

- Angle stacks were created at angle ranges: 0-10, 10-20, 20-30.

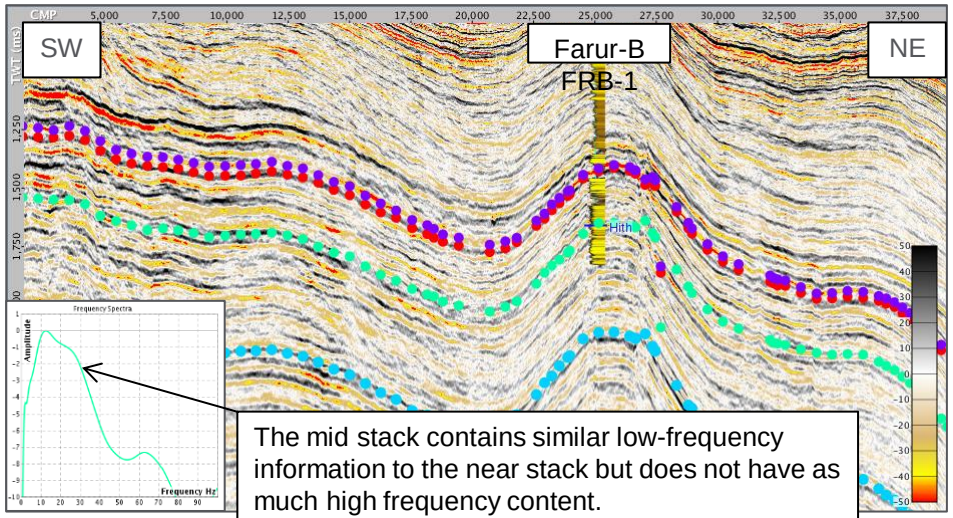


Spectral balancing: Before frequency balancing

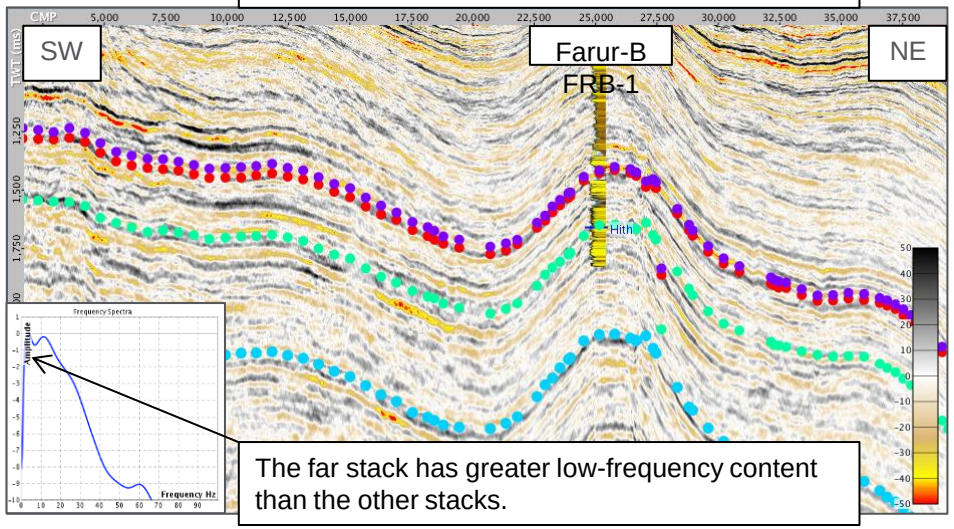
- Angle stacks and their frequency content before balancing.



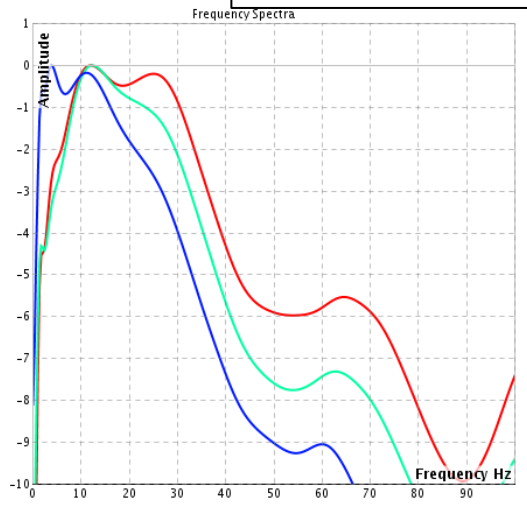
The near stack has greater high frequency content than the other stacks.



The mid stack contains similar low-frequency information to the near stack but does not have as much high frequency content.



The far stack has greater low-frequency content than the other stacks.

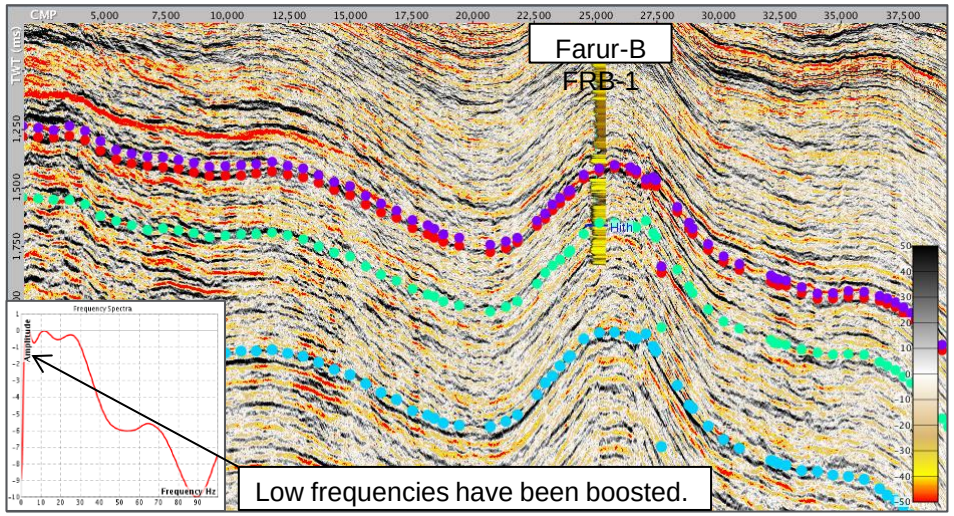


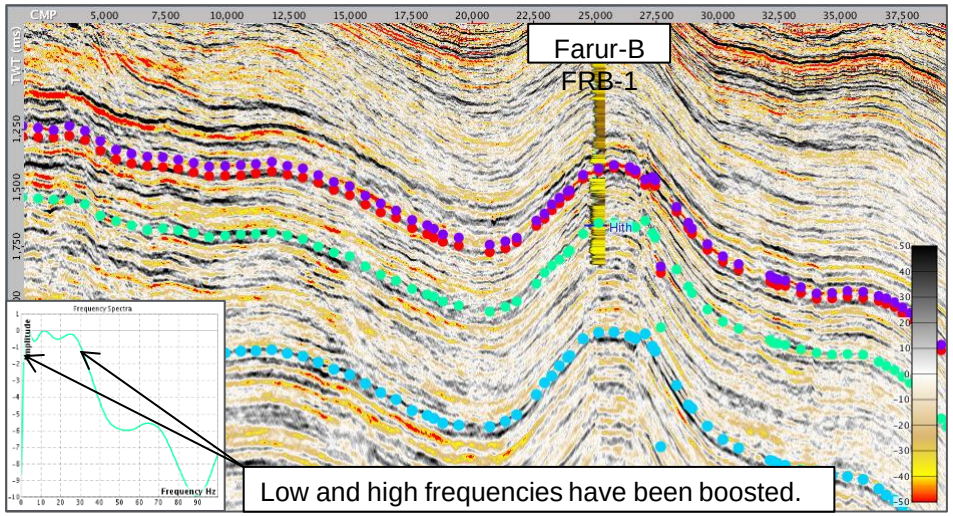
Frequency content is different for all stacks before frequency content has been balanced.

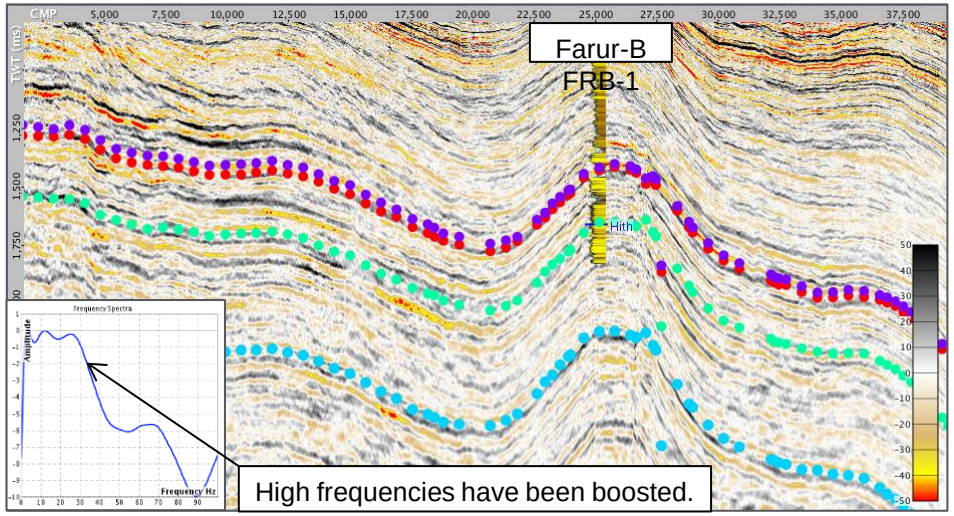
Near stack
Mid stack
Far stack

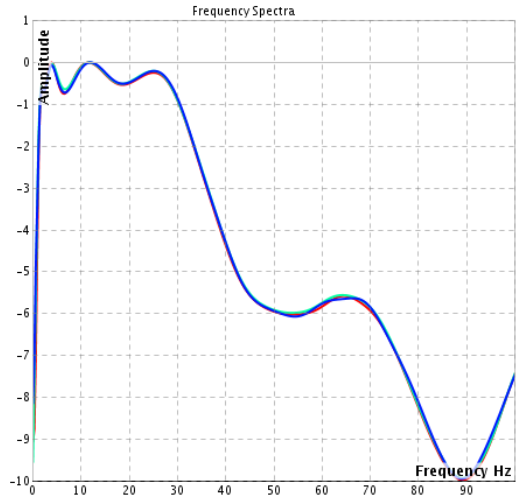
Spectral balancing: After frequency balancing

- Angle stacks and their frequency content after balancing.







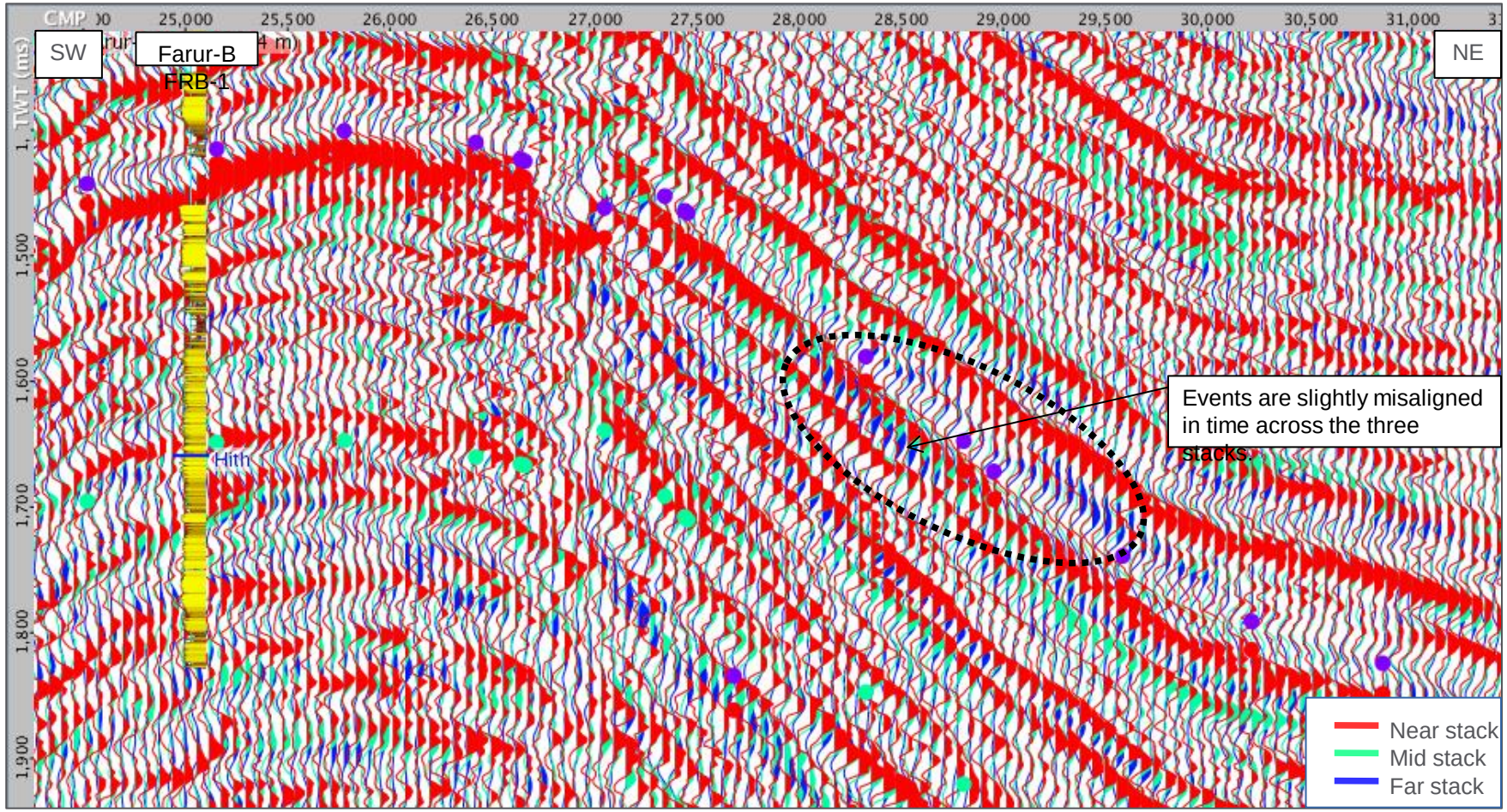


Frequency content has been balanced to the far stack below 10 Hz and balanced to the near stack on frequencies above 10 Hz.

Near stack
Mid stack
Far stack

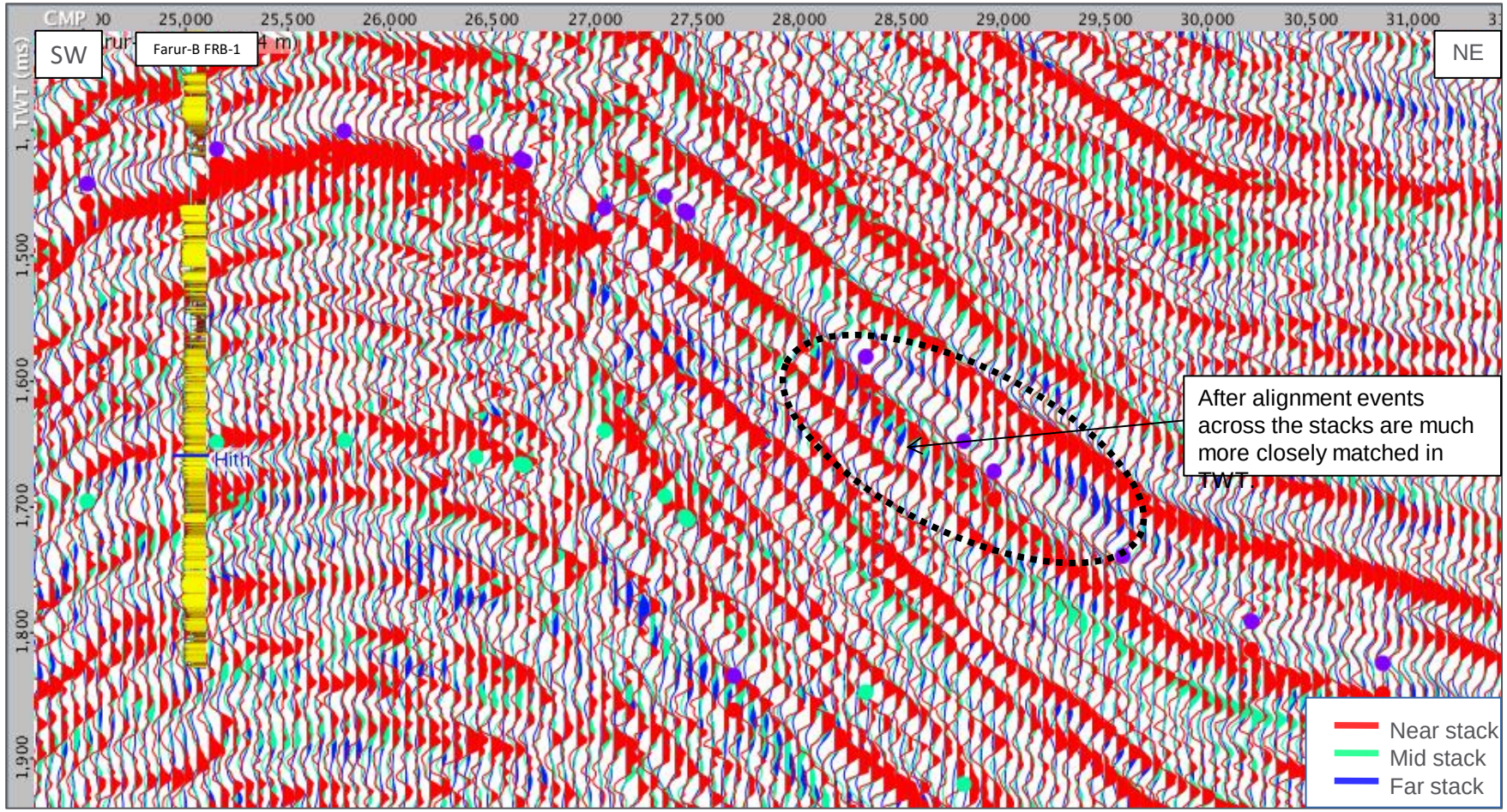
Stack alignment: Before alignment

- Angle stacks need to be aligned to each other so events match in time across the stacks in order to correctly calculate AVA across the stacks.



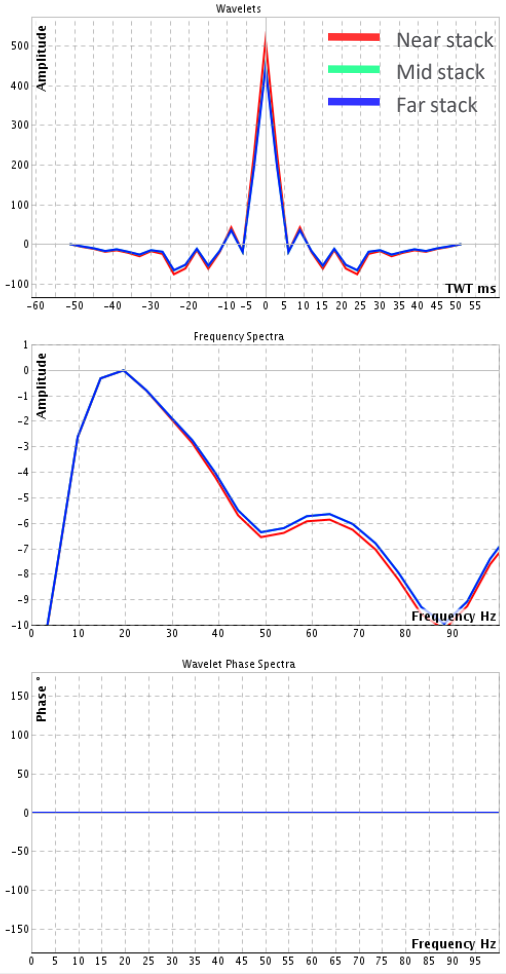
Stack alignment: After alignment

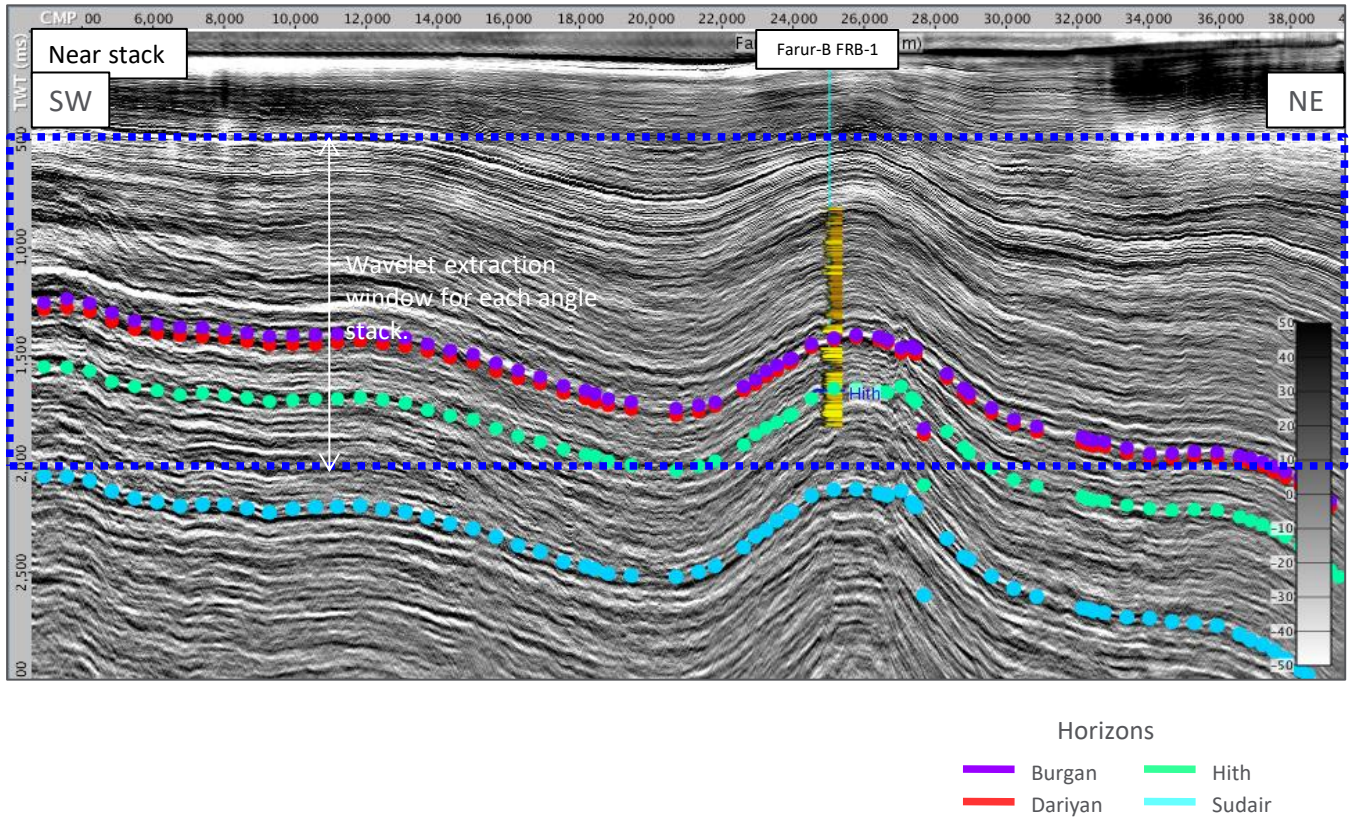
- After alignment events across the stacks have a much more similar TWT. This allows AVA to be more accurately measured across the stacks.



Wavelets

- Wavelets were extracted from each angle stack within a window of 500-2000 ms along the 1080AB line.

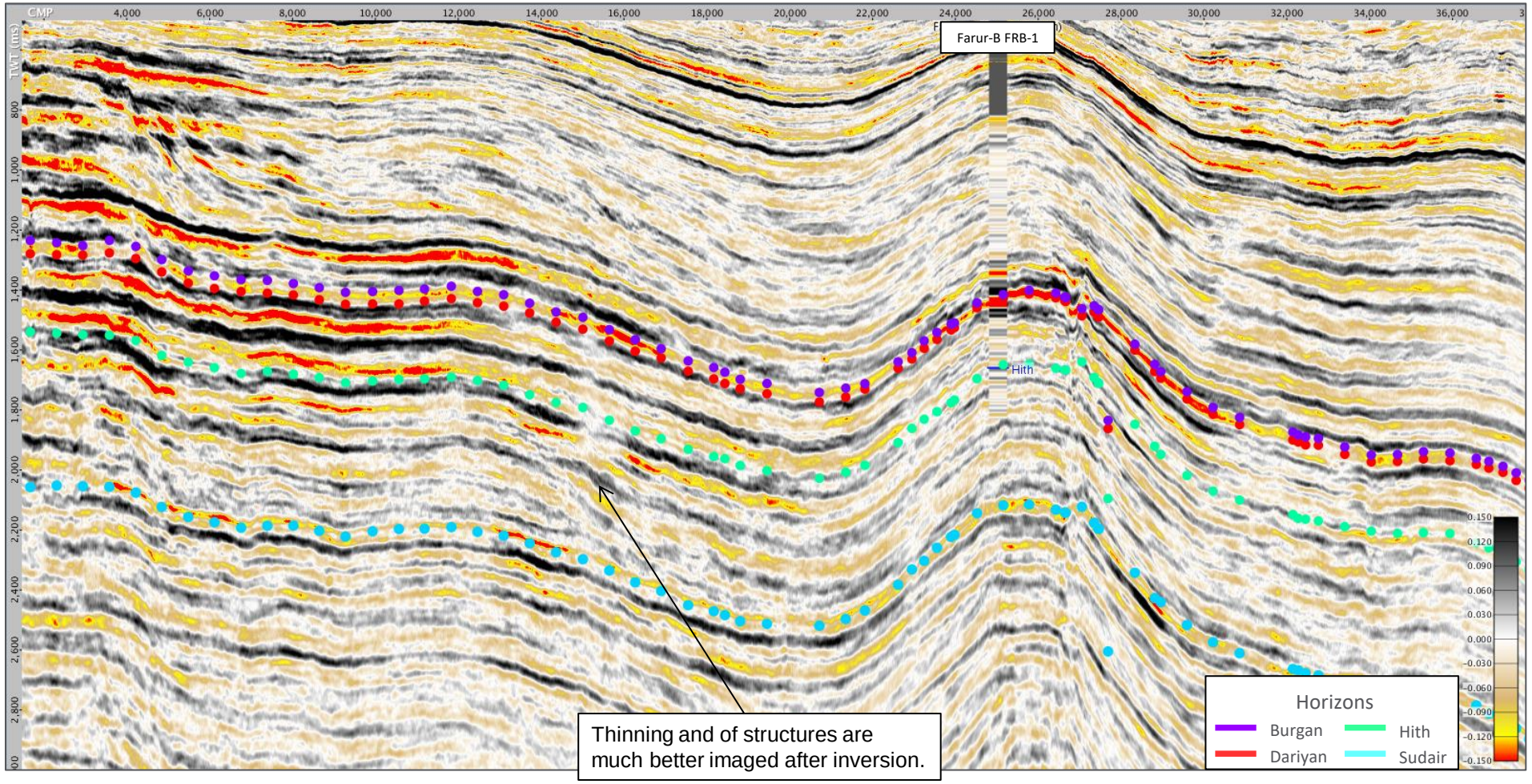




Horizons

Burgan
Dariyan
Hith
Sudair

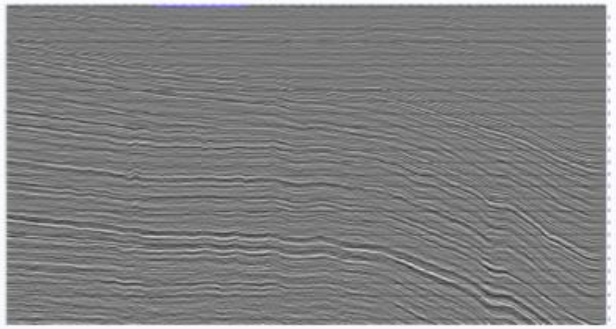
Line 1080AB: P-impedance volume



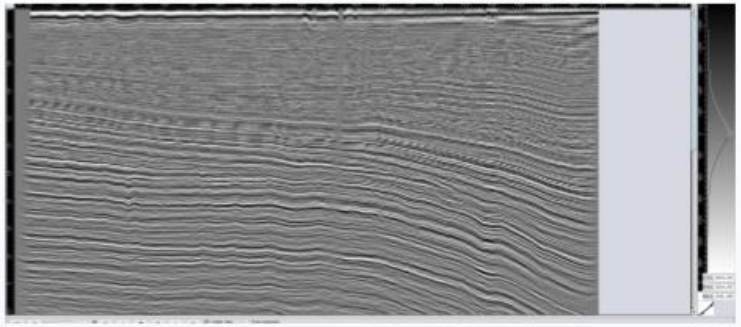
- The inverted P-impedance volume shows structure much more clearly than the intercept volume as noise and side lobes are removed.

Prony Decomposition

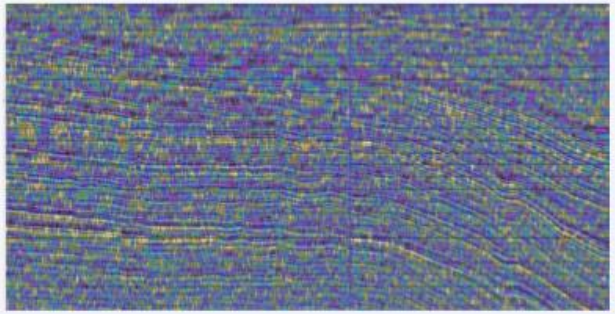
Original seismic

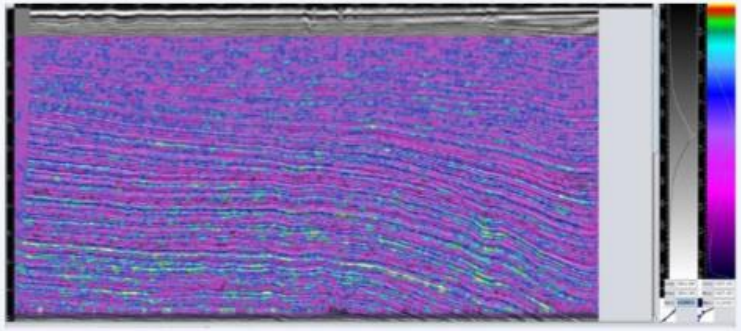


Re-Processed seismic



Q-factor extracted from seismic using Prony Decomposition





Rocks with the best reservoir properties are highlighted

3

Prony Decomposition

A unique decomposition series which (compared to Fourier Series and others) fits sums of damped complex exponents. And, apart from amplitude, phase and frequency, it also computes damping coefficients (1/Q) of the signal components. Seismic amplitudes attenuate more in rocks with fluids, especially at high frequencies. Thus, expressing Q-factor from the seismic section allowed to see reservoirs directly.

Required: noise free data (otherwise more complex regularization is required) and true frequency.

Phase Decomposition

Allows to separate seismic reflectors containing Hydrocarbons and not.
Required: accurate 0-phase reflector! HC brightening on 90- and disappearing on 0. (Ref. Vita Kalashnikova)

Conclusions

With vast oil & gas reserves Iran is a very attractive country for foreign investment.

The original and reprocessed PC-2000 multiclient seismic data package and supporting data are the only data available to:

- **evaluate properly the potential of offshore Iran**

- **define successfully core areas of interest for E&P companies**

- **increase significantly applicant's scores in any bidding procedure in Iran (technical capability is 40%)**

This is a world class opportunity with large reserves to be found and developed.